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CONTENTS

OF

VOL. XXXI.

	Page
On the Development of Some Marine Bivalves, with Special Reference to the Shelled Larvae. (Pls. I~III)	
—Itirô MIYAZAKI	1
On the Soundings from the Banks between the Oga Peninsula and Sado Island, in the Northeastern Part of the Japan Sea. (Pls. IV~VII)	
—Hirosi NIINO	11
On the Development of Some Marine Bivalves, with Special Reference to the Shelled Larvae. II. (Pls. VIII~XII)	
—Itirô MIYAZAKI	35
A Description of a New Alpheoid Shrimp from Japan. (Pl. XIII)	
—Ituo KUBO	43
Two New Littoral Macrurous Crustaceans from Japan. (Pls. XIV, XV)	
—Ituo KUBO	47
On Japanese Penaeid Crustaceans belonging to the Genus <i>Parapenaeopsis</i> , with a Description of one New Species. (Pl. XVI)	
—Ituo KUBO	55
A New Homoloid Crab from Japan. (Pl. XVII)	
—Ituo KUBO	63
On the Growth of <i>Ecygnis cardinalis</i> (LACÉPÈDE).	
—Ken-ichi EBINA	69
Studies on the Scorpaenoid Fishes of Japan.	
III. On the External and Internal Characters of <i>Sebastichthys longispinis</i> Mihi and <i>Sebastichthys brevispinis</i> , nom. nov., Compared.	
—Kiyomatsu MATSUBARA	79
A Review of Two Genera of the Japanese Sclerophorids, <i>Ereunias</i> and <i>Marukawichthys</i> with Special Reference to their Systematic Positions.	
—Kiyomatsu MATSUBARA	97
A New and a Rare Ophidioid Fishes from Japan.	
—Kiyomatsu MATSUBARA	115
Biometry of Two Species of Japanese Cardinal-fishes, with Special Reference to their Taxonomy.	
—Kiyomatsu MATSUBARA	119
Larvae and Young of Fishes found in the Vicinity of Kominato, II—VI.	
—Syûya NAKAMURA	131

On the Development of Some Marine Bivalves, with Special Reference to the Shelled Larvae.

(Pls. I~III)

Itirô MIYAZAKI

(Received June 25, 1935)

Despite the great abundance of bivalves in the waters of Japan, our knowledge of their larval development is very scanty. It is almost hopeless to identify shelled larvae of the group in question, except those of a few species, amongst other plankton organisms, a condition which is much to be regretted from the view-point of fishery biology.

Since I have been in residence at the Kanazawa Marine Biological Laboratory, which is situated about 8 miles south of Yokohama, I have had opportunity to obtain shelled larval stages of several marine bivalves either by artificial insemination of the ova or by inducing the mollusks to spawn in laboratory aquaria. The present paper is the first instalment of my study on their development, stress being laid on the shelled larval stages.

It is with great pleasure that I acknowledge my indebtedness to Professor I. Amemiya, of the Tokyo Imperial University, for the painstaking revision of the manuscript and to Dr. A. Terao for many valuable suggestions. My hearty thanks are also due to Messrs. Taki and Osima, of the Tokyo Imperial University, and to Mr. Hosina who helped me in various ways.

1. *Mytilus crassitesta* Lischke.

This species is widely distributed along the shores of Japan, and its spawning season varies greatly according to its habitat. In the vicinity of the Kanazawa Laboratory, the season lasts from the last decade of December to the first decade of April. The material, on which the present study is based, were more than 50 in number and found attached on the shells of the live oysters hung down in sea-water near the laboratory building. Undoubtedly they were all about one-year old, measuring 2.4 cm long and 3.8 cm high on the average.

The fertilized ova were transferred to glass-cups, 9 cm in height and 7 cm in diameter, and were supplied with sea-water which had been corked for long time before the experiment to ensure self-sterilization. The specific gravity of this water was at first 1.02330 (σ_{15}) and changed to 1.02400 during the course of the breeding. The food with which the larvae were fed consisted of *Chlorella vulgaris*, zoospores of *Ulva*, and minute naviculoid diatoms.

My glass-cup culture of the larvae was extended to about 100 days, but it was most successfully carried on during the three months from March to May, and the water-temperature varied 7°~12°C in March, 11°~15°C in April, and 13°~17°C in May.

Spawning. Artificial fertilization was tried many times, but in vain. Spawning was observed repeatedly in table aquaria, the "trigger temperature" appearing to be about 10°C as shown in the following lines:—

Date of spawning	Water-temperature
Dec. 23, '33	10.9°C.
Jan. 14, '34	—
Jan. 15, „	—
Jan. 18, „	10.0°C.
Mar. 1, „	9.8°C.
Mar. 2, „	10.0°C.

The spawning sets in without any particular movement of the shell. Once started, it lasts for about an hour, not to be interrupted by a sudden change of water-temperature (from 10° to 30°C) or mechanical stimuli. When the mussel is taken out of water during the spawning act, it stops the discharge of the sexual elements by closing the shell. But as soon as it is put back to the former medium, it opens the shell to resume the discharge. One time the present author deprived a spawning male of its right shell and placed it back in sea-water. This sample was found to continue the discharge for an hour or so without any break whatever.

The spawning of this species was successfully induced by adding spermatozoa of the same species, as observed by Galtsoff in *Ostrea*.

Spermatozoon. The head is oval, ends anteriorly in a conical protuberance, and tapers posteriorly, measuring 5 μ in length and 2.6 μ in width as is the case with that of *Mytilus edulis*. But the tail is longer than that of the latter species, attaining a length of 60 μ . The middle piece is strongly refractive, and consists of two chondriospheres. When fresh from the testis, the spermatozoa are immobile. But they start

active movement in sea-water after a lapse of time of about 30 minutes at $8^{\circ}\sim 9^{\circ}\text{C}$. The movement is a counter-clockwise spiral one. Although artificial fertilization was not successful, the spermatozoa were found drawn to the cortical layer of the ovum of the same species. They were also activated by the fertilizin of another mollusk, *Hiatela arctica*, but did not cause the eggs to cleave.

Ovum. It assumes an elliptical form with its major axis ca. 77μ and its minor axis ca. 60μ long when it is freshly laid. The colour is pale brownish-yellow.

Earlier development. The cleavage stages were repeatedly observed and proved to be the same as those in *Mytilus edulis* and the like in the essential features as illustrated in Pl. 1, figs. 3-16. Time required to reach respective stages at an average water temperature 11.2°C and specific gravity 1.02330 (σ_{15}) is given in Table 1.

Table 1. Earlier developmental stages of *Mytilus crassitesta*.

Hours	Minutes	Stage
—	25	Protrusion of 1st polar body.
—	40	Protrusion of 2nd polar body.
1	20	Constriction of 1st polar lobe.
1	25	First segmentation, trefoil stage.
2	—	Retraction of 1st polar lobe.
2	25	Constriction of 2nd polar lobe.
2	37	Completion of 2nd cleavage, with the retraction of 2nd polar lobe.
3	20	5-cell stage.
3	30	8-cell stage.
16	26	Formation of two entoblast cells; embryo rotates in the medium by means of fine cilia.
53	50	Shell developed, but not yet large enough to enclose the body.

Later development. It is rather easy to obtain later developmental stages of the present species by surface tow. These naturally grown larvae were always found faster in development than those corresponding ones artificially reared in glass-cups which were placed in the laboratory. Inasmuch as the temperature of the laboratory room, in which the culture was continued, underwent a greater variation than that of the sea where the surface-towing was to be performed, the speed of the development of the larvae in the glass vessels was by no means regular. The

data tabulated in Table 2 are, therefore, nothing more than rough time-records of the development in the laboratory.

Table 2. Later development of *M. crassitesta*.

Time in days after fertilization	Dimension of shell (μ .)			Stage
	length	height	hinge line	
3	95	71	71	Hinge line straight, light purple; intestine short and thick; yolk granules abundant.
6	107	77	76	Very transparent, internal structures easily visible. Anterior adductor muscle appears; intestine becomes thinner and longer, making a loop on the left side of the body.
12	114	86	85	Shell margin faintly yellowish in colour.
34	129	96	85	Liver becomes visible; posterior adductor muscle develops.
72	173	143	85	Statocyst appears.
86	203	180		Umbo-stage. Eye-spot formed; foot becomes very large.

The resemblance between the larvae of the present species and those of the American species, *M. edulis*, is obvious up to the umbo stage. But the distinction from those of *Hiatela arctica* L., which appear at the same time with those of *M. crassitesta* as plankton near the Kanazawa Laboratory, is clear since the larval shell of *H. arctica* is shorter in hinge than in height until the shell attains 113μ in length whereas the hinge and height are nearly the same in the shell of *M. crassitesta* so long as it reaches a length of 114μ . At the umbo-stage the larva of *M. crassitesta* is easily recognizable by its small depth, relatively small umbo which is yellow in colour. It is also characterized by peculiar shape of the shell which is more pointed at the anterior end, absence of pigment along the mantle and oesophagus, green colouration of the liver, and presence of eye-spots.

2. *Teredo japonica* Clessin.

This species is very common around Kanazawa and its breeding covers the whole warm season of the year, extending from the first decade of June to the end of September. Incubated in the gill chamber during the entire embryonic development, the embryos at various stages are

easily obtainable. The functionless velum of the larva which is still in the gill chamber and the features of the advanced larva which leads a planktonic life point to the conclusion that the duration of the planktonic period is rather short. Those young shelled larvae which contain yolk granules abundantly within the body are deep yellow in colour along the margin of the shell and deep purple or violet along the hinge line. The ratio of height to length is smaller than unity up to the umbo-stage, although this ratio is not at all smaller than that of the larval shells of bivalves of other families. The ratio equals to one when the umbo-stage is reached, the shell being circular in outline with the diameter 161μ long. But the height grows faster than the length as the development advances. The larva of the later umbo-stage appears, therefore, somewhat elliptical in outline when viewed laterally. Gill-filaments are visible in the larva about 239μ long. The functioning of the velum is observable in the larva with its length ca. 243μ , and it makes the larva swim and crawl about in the medium. At this stage, the fundament of the teeth is formed along the anterior edge of the external surface of the valves. These teeth become mechanical apparatus for boring into the wood. The identification of such remarkably characteristic larvae of the present species in a plankton collection is consequently rather easy.

3. *Anomia lischkei* Dautzenberg et Fischer.

Although the members of the genus *Anomia* have a very wide range of distribution in Japan, two of the genus, viz., *A. lischkei* and *A. cytaeum* are the most predominant ones in this country. Of these two, *A. lischkei* is alone found in the vicinity of the Kanazawa Laboratory. There is no room for doubt that a series of peculiar larvae occurring from June to the first decade of September in plankton collections made near the Laboratory are referable to *A. lischkei* on the ground that they present characters of *Anomia* larvae as given by PELSENEER and STAFFORD. Such peculiarities as the asymmetry of the body, the transparency of the shell, and the brownish colouration of the liver make the larvae very conspicuous among other plankton organisms. It may be mentioned that the shell is, however, symmetrical in earlier "D-shaped" larvae and provided with teeth at both ends of the hinge. But the asymmetry is obvious in the shell 97μ long, the umbo of its left shell beginning to project. At the shell length of 180μ there appear eye-spots on both

sides of the body. The byssus sinus is observable on the right shell when the shell is ca. $187\ \mu$ long. The gill-filaments are recognizable on both sides of the body when the shell attains a length of about $200\ \mu$. Further development causes the asymmetry of the shell more conspicuous leading to greater growth of the left shell which finally encloses almost the whole body with right one serving as its lid.

4. *Parapholas quadrizonata* Spenger.

The spawning season of this species lasts from June to September in the neighbourhood of Misaki, whence the material were brought to Kanazawa. The author could obtain shelled larvae of the present species by rearing the artificially fertilized ova for two months. The young shelled larva is circular in outline in lateral view, measuring ca. $93\ \mu$ long, $89\ \mu$ high and $30\ \mu$ long along hinge line. The hinge line is faintly purple and the body is nearly transparent and colourless. The apical plate is destitute of any tuft of flagella in contradiction to such cases as in *Mytilus* and *Paphia* (Pl. III, fig. 1). At the time the shell is about $100\ \mu$ long and $92\ \mu$ high, the umbo is a little projecting, and both the shell margin and the liver are slightly tinged with light yellow (Pl. III, fig. 2). The largest one among those reared by the author measures about $177\ \mu$ long and $169\ \mu$ high; its valves on both sides are much alike in shape, its anterior and posterior margins similarly curved, and its umbos rather widely separated. Up to this stage the shell changes to deep yellow in colour, the liver yellowish green, and the umbo region dark purple (Pl. III, fig. 5). The characters of the larvae of the present species so far described tally in general with those of *Pholas* sp. which were put on record by Kändler.

5. *Lima basilanica* Adams et Reeve.

This species inhabits the waters of southern Japan. It spawns mostly from the last decade of April to the last decade of October around the Kanazawa Laboratory. The sexes are separate; the female sexual elements are vermillion or red in colour, and the male ones milky white. The artificial fertilization was successful and the larval stage with the shell enclosing the body was reached after about 24 hours, the water temperature being then about 22.5°C and specific gravity 1.02410 (σ_{15}). It is very remarkable that the peculiar pigment of the ovum does not completely disappear until this stage, since such young shelled larvae of

many other kinds of bivalves are mostly transparently colourless and tinged faintly with purple on the hinge line. The larva of *L. basilanica* at this stage measures about 71μ in length, 61μ in height, and 50μ along the hinge line which is a little depressed in the middle. A tuft of flagella is found on the apical plate of the larva at this stage of development as is the case with that of *Mytilus*, *Paphia*, *Mysela*, and *Hiatela* (Pl. III, fig. 6).

When the larva attains a size 83μ long and 75μ high, it almost loses the pigment originated from the ovum but it shows in the liver yellowish green or deep green and along the hinge line red pigment which persists long afterwards (Pl. III, fig. 7).

At the time the shell is about 115μ in length and 113μ in height, it is almost circular in outline when viewed laterally. At the early umbo-stage which is about 122μ long and 121μ high, a light yellowish red pigment is seen around the mouth and oesophagus. The post-larval stage is characterized by the posteriorly much protruded shell which is about 160μ in both length and height (Pl. III, fig. 10).

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Explanation of Plates.

Abbreviations—*a. ad*: anterior adductor muscle; *an*: anus; *e*: eye-spot; *eb*: entoblastic cell; *f*: foot; *fl*: flagellum; *g*: gill anlage; *it*: intestine; *l*: liver; *lk*: larval kidney; *m*: mouth; *ot*: otocyst; *p. ad*: posterior adductor muscle; *pg*: pedal ganglion; *rt*: retractor muscle; *st*: stomach; *v*: velum; *vg*: visceral ganglion; *1 pl*: first polar lobe; *2 pl*: second polar lobe.

Plate I. *Mytilus crassitesta* Lischke.

Fig. 1. Mature egg immediately after being shed.

Fig. 2. Spermatozoa.

- Fig. 3. Protrusion of the first polar body.
 Fig. 4. Appearance of the second polar body.
 Fig. 5. Constriction of the first polar lobe.
 Fig. 6. The first cleavage, resulting in the so-called trefoil stage.
 Fig. 7. Retraction of the polar lobe.
 Fig. 8. Macromere and micromere in resting stage.
 Fig. 9. Constriction of the second polar lobe.
 Fig. 10. Second cleavage.
 Fig. 11. 4-cell stage. Second polar lobe fused with the macromere D.
 Figs. 12-13. 5-cell stage.
 Fig. 14. 8-cell stage.
 Fig. 15. Many-cell stage.
 Fig. 16. Formation of two entoblastic cells. At this stage embryo begins free swimming.
 Fig. 17. Trochophore stage.
 Fig. 18. Young shelled larva. Shell is large enough to enclose nearly the whole body. Length ca. 95μ ; height 71μ ; hinge line 71μ .
 Fig. 19. Shell ca. $114 \times 86 \times 85\mu$.
 Fig. 20. Shell ca. $129 \times 96 \times 85\mu$.
 Fig. 21. Shell ca. $173 \times 143 \times 85\mu$.
 Fig. 22. Shell ca. $203 \times 180\mu$. Larva was raised up to this stage.

Pl. II, Figs. 1-7. *Teredo japonica*.

- Fig. 1. Young shelled larva, ca. $88 \times 79 \times 43\mu$.
 Fig. 2. Shell ca. $100 \times 90 \times 45\mu$.
 Fig. 3. Shell ca. $120 \times 117\mu$.
 Fig. 4. Umbo-stage. Shell ca. $161 \times 161\mu$.
 Fig. 5. More advanced stage, ca. $229 \times 261\mu$.
 Fig. 6. Planktonic form. Shell ca. $243 \times 287\mu$.
 Fig. 7. Crawling larva, *tt*: teeth along the anterior margin of the shell; *ds*: dorsal siphon; *rs*: ventral siphon.

Pl. II, Figs. 8-15. *Anomia lischkei*.

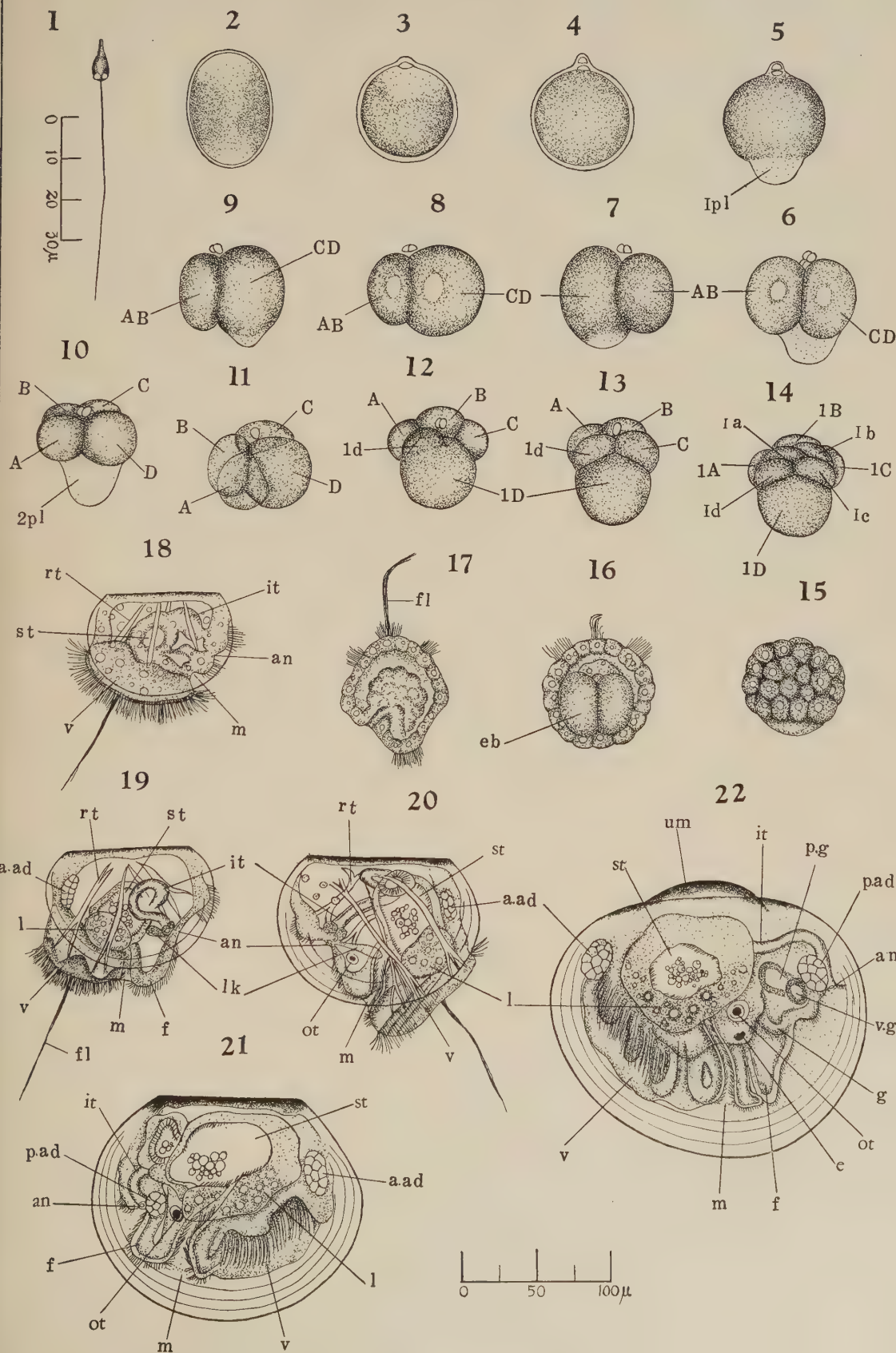
- Fig. 8. D-shaped larva, ca. $87 \times 70 \times 62\mu$.
 Figs. 9-11. Early umbo-stage. Shell ca. $97 \times 85-108 \times 100\mu$. Left umbo begins to swell up.
 Figs. 12-13. More advanced stage.
 Fig. 14. Post larval stage, *si. by*: byssus sinus.
 Fig. 15. Formation of byssus sinus. Viewed from left side. *ls*: left shell; *rs*: right shell.

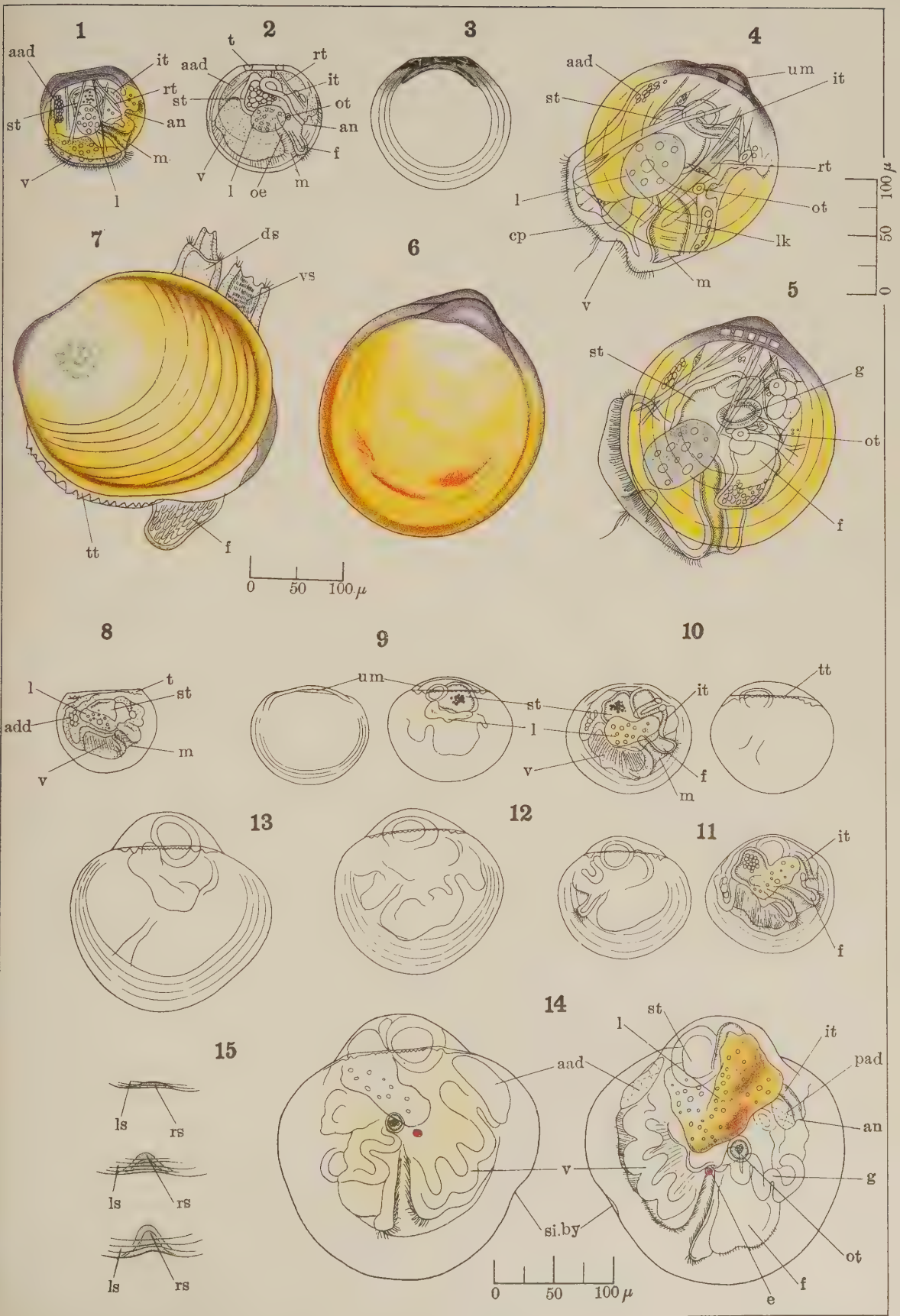
Pl. III, Figs. 1-5. *Parapholas quadrizonata*.

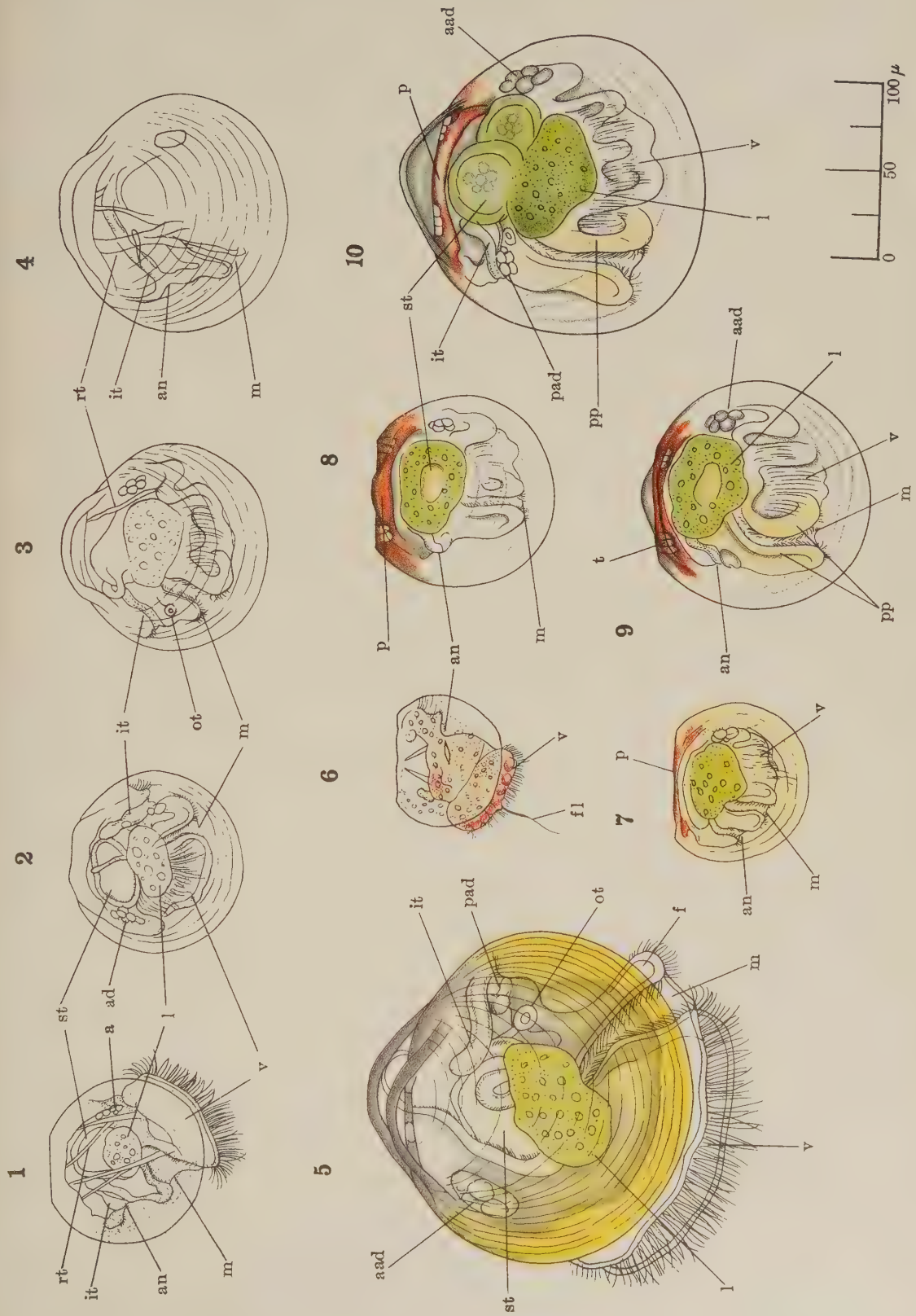
- Fig. 1. Young shelled larva. Shell ca. $93 \times 89 \times 90\mu$.
 Fig. 2. Growth-line of shell visible. Shell ca. $900 \times 92\mu$.
 Fig. 3. Early umbo-stage. Shell ca. $120 \times 115\mu$.
 Fig. 4. More advanced umbo-stage.
 Fig. 5. The largest form raised by the writer. Shell ca. $177 \times 169\mu$.

Pl. III, Figs. 6-10. *Lima basilanica*.

- Fig. 6. Young shelled larva, large enough to enclose the body.
Fig. 7. Shell $83 \times 75 \mu$. Larva raised by artificial insemination.
Fig. 8. Early umbo-stage. Shell $115 \times 113 \mu$.
Fig. 9. Umbo-stage. Special colouration along the oesophagus (p.p) and along the hinge line (p).
Fig. 10. The largest form obtained in plankton collection by the author.







On the Soundings from the Banks between the Oga Peninsula and Sado Island, in the Northeastern Part of the Japan Sea.

(Pls. IV~VII)

By HIROSI NIINO.

(Received August 26, 1935)

Contents.

	Page
1. Introduction.	11
2. General Features of the Banks, Islands and the Continental Shelf along the Mainland of Japan.	13
a. The Banks.	13
b. The Islands.	13
c. The Flat Plain and Steep Slope on and around the Banks and the Islands.	14
d. The Continental Shelf.	14
3. The Bottom Character Protracted from Chart No. 145.	17
4. Soundings from the Banks and Their Environs.	17
a. Rock Fragments.	17
b. Gravels.	24
c. Sand.	26
d. Organisms.	26
e. Relation between Topography and Bottom Deposits.	28
5. Summary and Conclusions.	29
6. Literature.	32

1. INTRODUCTION.

It is well known that there exists a conspicuous zone⁽¹⁴⁾ of islands and banks fringing the Japan Sea along North Japan. The northeastern end of this zone which lies between the Oga Peninsula^(a) and Sado Island^(b) comprises two islands and seven banks, i. e., Tobisima^(c), Aosima^(d), Oga-Muose^(e), Siguri^(f), Tyôkaisyô^(g), Aosimasyô^(h), Okinose⁽ⁱ⁾, Hyôtansyô^(j), Mukôse^(k) and Mukôse-no-Okinose^(l). In 1930, the Surveying Ship *Sôyô-maru*⁽²²⁾ of the Imperial Fisheries Experiment Station dredged thirty bottom samples from those banks and their environs. Those samples were placed at my disposal for examination through

(a) 男鹿半島 (b) 佐渡島 (c) 飛島 (d) 栗生島 (e) 男鹿向瀬 (f) 新礁 (g) 島
海礁 (h) 栗生島礁 (i) 沖ノ瀬 (j) 瓢箪礁 (k) 向瀬 (l) 向瀬ノ沖ノ瀬

Table I. Dredge-stations between Oga Peninsula and Sado Island.

Station Number	North Latitude	East Longitude	Depth in meters	Bottom temperature °C.	Bottom water specific gravity S_{415}	Distance from land in km.
600	38 33 37	138 21 05	168 ^m	9.5 ^{°C}	25.11 ^{S₄₁₅}	28.3 ^{km}
601	38 46 30	138 18 40	454	1.3	25.28	49.6
602	38 47 00	138 34 30	205	4.7	25.31	50.5
603	38 41 30	138 42 05	210	6.3	25.31	43.0
604	38 20 37	138 34 45	444	1.1	25.25	12.8
605	38 31 00	138 31 37	139	11.4	25.47	19.0
606	38 50 40	138 44 20	117	11.7	25.47	59.4
607	38 56 40	138 36 07	165	4.7	25.27	67.6
608	39 04 32	138 43 45	140	15.2	25.49	89.9
609	39 06 45	139 01 00	669	1.8	25.26	47.4
610	38 52 33	139 02 50	145	11.9	25.47	47.0
611	38 20 40	138 54 00	143	12.4	25.52	29.4
612	38 21 15	139 07 30	112	16.4	26.61	12.6
613	38 32 30	139 01 50	254	3.2	25.18	19.0
614	38 42 29	139 07 28	510	1.4	25.29	26.5
615	38 45 50	139 21 15	439	1.1	25.25	31.9
616	39 08 00	139 43 27	106	16.4	25.55	12.6
617	38 59 50	139 38 07	106	15.4	25.61	17.1
× 618	39 07 30	139 30 45	135	3.1	25.58	6.1
619	39 16 27	139 29 15	338	4.4	25.28	9.6
620	39 22 05	139 35 40	139	2.9	25.47	18.8
621	39 16 00	139 49 45	93	16.4	25.55	7.6
622	39 23 34	139 50 00	218	5.5	25.31	15.5
623	39 30 00	139 52 47	93	16.1	25.61	14.5
624	39 36 30	139 53 11	73	20.3	25.50	15.0
625	39 42 30	139 55 46	51	21.9	25.39	11.5
626	39 46 07	139 49 45	70	15.2	25.55	9.6
× 627	39 36 30	139 45 15	148	12.5	25.52	27.0
628	39 39 20	139 31 45	148	12.6	25.61	29.4
629	39 44 00	139 32 07	247	3.7	25.25	23.5
630	39 52 45	139 34 00	150	11.3	25.47	12.5

× The bottom sample not preserved.

the kindness of Mr. H. Marukawa, expert of the Imperial Fisheries Experimental Station, to whom the writer wishes to take this opportunity of recording his warmest thanks.

2. GENERAL FEATURES OF THE BANKS, ISLANDS AND CONTINENTAL SHELF ALONG THE MAINLAND OF JAPAN.

A. *Banks.* Oga-Mukôse and Siguri form a "gourd-shaped bank" about twenty kilometers west off the Oga Peninsula, the former lying on the north and the latter on the south. The shallowest part of Oga-Mukôse is 102 m. deep on its north-western corner and that of Siguri is 142 m. on its north-western corner. The two banks are separated from the submarine platform along the west coast of the Oga-Peninsula by a channel, more than 300 m. in depth. Tyôkaisyô is situated about 40 km. west off Port Sakata^(m); it is oval in shape, and the shallowest part is 137 m. deep on its west side. Aosimasyô is a small bank lying about 10 km. north-west of Aosima Island, the shallowest part being 137 m. deep at its southern end. Okinose is a small bank 19 km. distant from Himezaki⁽ⁿ⁾ in Sado Island and the shallowest part is 157 m. deep. Hyôtansyô is a large bank lying parallel to and about 20 km. west off the coast of Sado Island, its shallowest part being 102 m. in depth. To the north-east of Hyôtansyô lies a bank called Mukôse-no-Okinose; it is hook-shaped, its northern part bending eastward at right angles to the general trend of the banks.

B. *Islands.* Tobishima is an isolated island about 30 km. off Port Sakata. Though the island occupies a small area above sea level, there develops a broad submarine platform called "Sirose"^(o) in its northern part. The depth of this submarine platform is 120 m.-140 m., coinciding with that of the flatplains on the neighbouring banks. There is another shallower flatplain of 60-80 m. in depth developed around this island, flat plains of this level being also recognized around Aosima and on the continental shelf bordering the mainland of Japan. Aosima, a small island, is situated midway between Tobishima and Sado Island, only 18 km. off the coast of Japan. This island rises from the continental shelf and is encircled by a broad submarine platform about 80 m. below sea level. Sado Island is the largest island in the Japan Sea and lies about 40 km. off the city of Niigata. Around Sado Island, especially off Cape Danzaki^(p), its north-western corner, there develops at a depth

(m) 酒田港 (n) 姫崎 (o) 白瀬 (p) 弾崎

of 120-140 m. a broad submarine platform called Wasizaki-no-se^(q).

The peninsula of Oga extends in a westerly direction, embracing a large lagoon called Hatirôgata^(r), being connected with the mainland by a narrow sand bar. Geologically speaking, the Oga Peninsula^(20, 24) was once an island which became united with the mainland in the latest geological age.

With the exception of Aosima, all the banks and islands rise from the deep sea floor along the border of the continental shelf along the mainland. But if one traces the 400 m. bathymetric line, Sado Island, Hyôtansyô, Aosima, Tobisima, Oga-Mukôse, Siguri, Aosimasyô are found to be connected with the mainland, while Mukôse-no-Okinose, Tyôkaisyô, and Okinose still remain as isolated elevations in the deep sea floor of the Japan Sea.

C. *The Flat Plain and Steep Slope on and around the Banks and the Islands.* The shapes of the banks outlined by the 200 m.-bathymetric line are various. Each bank has a significant flat and broad plain on its top, its surface inclining at an angle less than 1° within the limit of 140-160 m. below sea level. The margin of the flatplain abruptly descends to the deep sea floor, or, in other words, the inclination of the margin of the banks is several times steeper than that of the flat plain itself. The banks represent thus submarine tilted blocks, with the steepest inclination close to the highest or shallowest point.

D. *Continental Shelf.* Along the coast of the mainland, the sea floor inclines very gently seaward. The average inclination within the depths from 0 to 100 m. is $23'$; that of 0 to 140 m. is $31'$, while that of 140-200 m. is $1^\circ 15'$, thus at the depth of 140 m. the sea floor increasing in gradient abruptly. If the continental shelf is defined as the sea floor above the steep slope which directly descends to the deep sea, that of this region is confined within the line of about 140 m.

It should be noticed that the depth of the tops of the banks closely coincides with that of the continental shelf and that there exists another shallower flat plain around the islands at the depth of 60-80 m., elevating on the continental shelf.

The dimensions of the banks, islands and continental shelf are given in Table II.

(q) 鷗崎瀬 (r) 八郎潟

Fig. 1, b

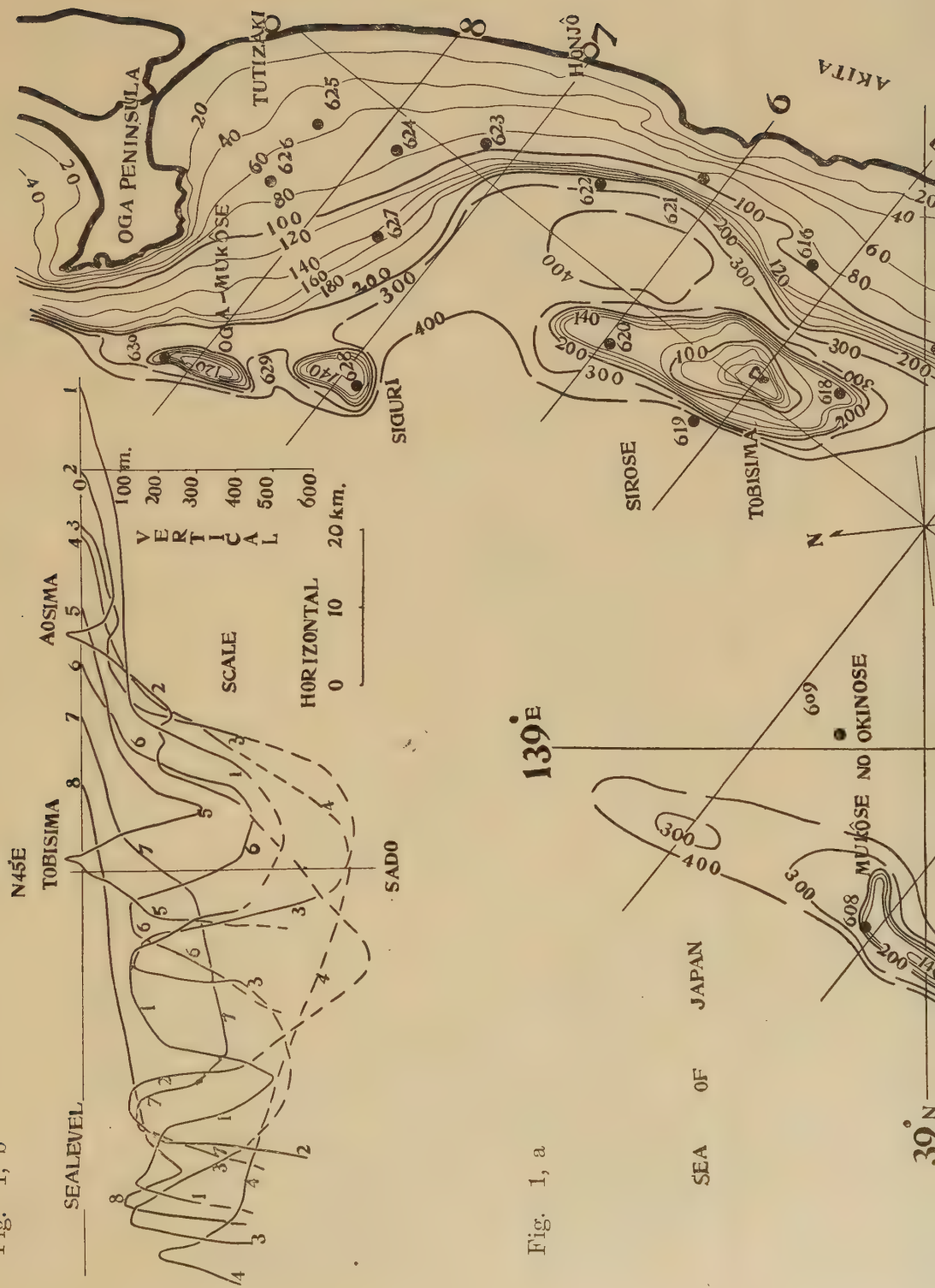
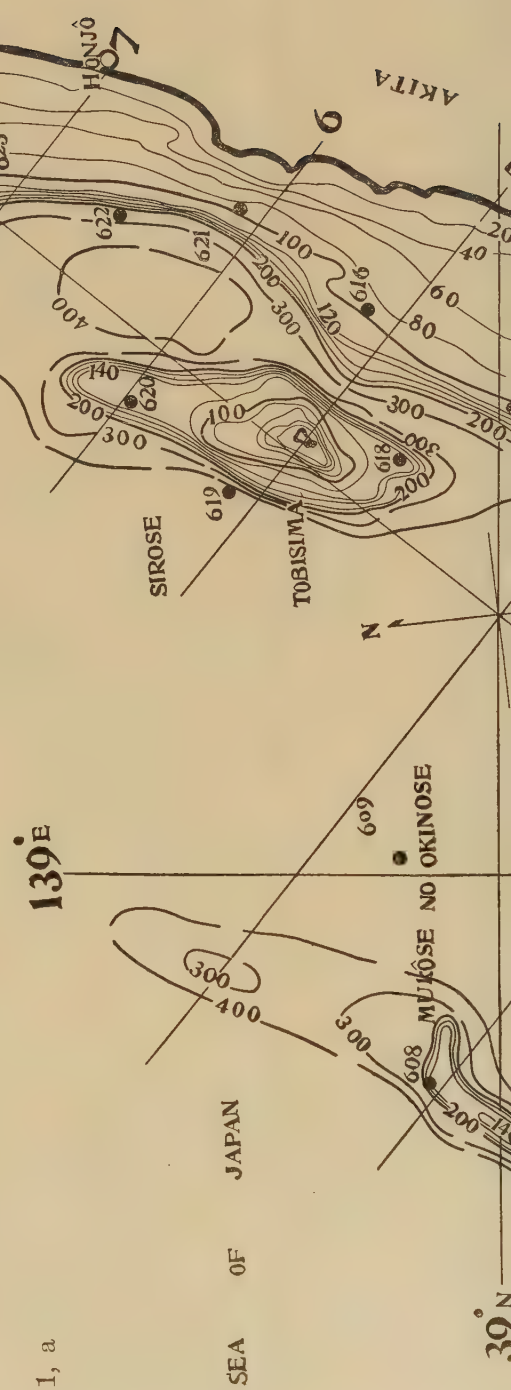


Fig. 1, a



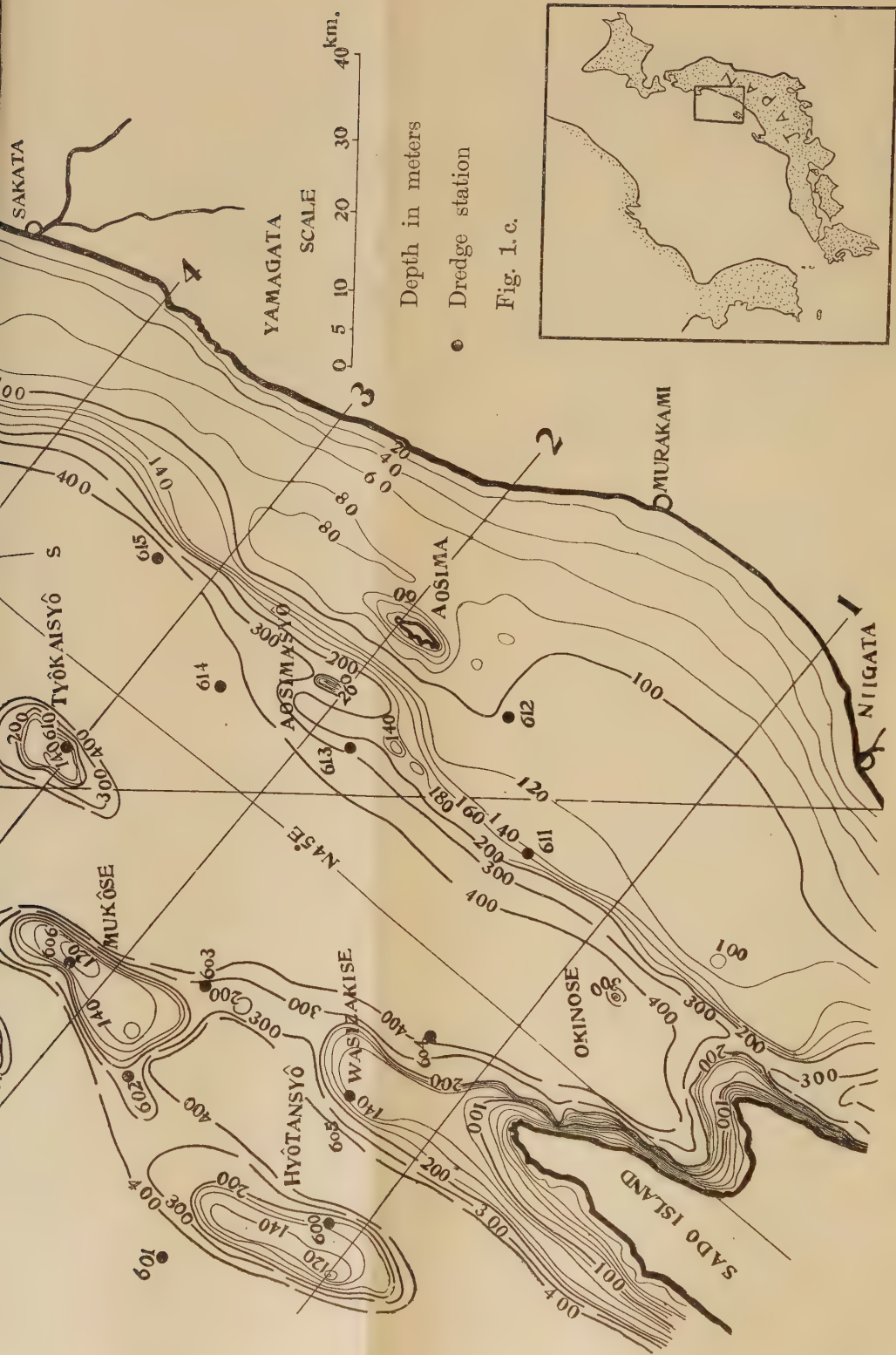


Fig. 1, a. Bathymetric features of the banks. (black spots indicate the sounding stations, contour interval 20m).

b. Section.

c. Sounding area.

Table III. The Inclinations of the steepest parts on the slopes around submarine reliefs.

Position		Measured portion on the marginal slope of submarine relief									Direction of the inclination of Bank
		Side	Range of slope (m.)	Inclination of the steepest point	Side	Range of slope (m.)	Inclination of the steepest point	Side	Range of slope (m.)	Inclination of the steepest point	
Bank	Oga Mukôse	W	120-200	5°43'	E	120-200	3°31'	—	—	—	W→E
	Siguri	W	140-200	4 18	E	140-200	3 17	—	—	—	W→E
	Tyôkaisyô	W	140-200	9 45	E	160-200	2 52	—	—	—	W→E
	Mukôseno-Okino	W	160-200	4 45	E	160-200	4 45	—	—	—	—
	Mukôse	W	120-200	1 23	E	140-200	4 17	—	—	—	E→W
	Hyôtansyô	W	140-200	3 16	E	140-200	1 20	—	—	—	W→E
Island	Sirose	W	0-100	2 35	E	0-100	1 54	N	140-200	4°45'	^a W→E
	"	W	100-200	1 26	E	100-200	5 43	—	—	—	^b E→W
	Aosima	W	0-60	2 52	E	0-60	2 52	N	80-120	0 46	^a W→E
	"	W	0-120	1 44	—	—	—	N	140-200	3 26	^b E→W
	"	W	120-200	1 44	—	—	—	—	—	—	E→W
	Sado Island	W	0-120	1 16	E	0-200	8 46	—	—	—	—
	Wasizaki-no-se	W	140-200	1 44	E	140-200	4 17	—	—	—	E→W
Continental shelf facing the Island or the Bank	Oga Peninsula	W	0-100	2 04	—	—	—	—	—	—	—
	"	W	100-200	0 46	—	—	—	—	—	—	—
	Between Tobisima and Mainland	W	0-100	0 26	—	—	—	—	—	—	—
	"	W	100-200	0 55	—	—	—	—	—	—	—
	Between Aosima and Mainland	W	0-60	0 33	—	—	—	—	—	—	—
	Between Sado Island and Mainland	W	0-140	0 14	—	—	—	—	—	—	—
	"	W	0-100	0 27	—	—	—	—	—	—	—
	"	W	140-200	3 26	—	—	—	—	—	—	—
Continental shelf	"	W	100-140	0 16	—	—	—	—	—	—	—
	Off Akita	W	0-100	0 15	—	—	—	—	—	—	—
	"	W	100-200	0 30	—	—	—	—	—	—	—
	Off Honjô	W	0-100	0 30	—	—	—	—	—	—	—
	"	W	100-200	2 18	—	—	—	—	—	—	—
	Off Ôwata	W	0-100	0 28	—	—	—	—	—	—	—
	"	W	100-200	0 45	—	—	—	—	—	—	—
	Off Niigata	W	0-100	0 18	—	—	—	—	—	—	—
	"	W	100-140	0 05	—	—	—	—	—	—	—
	"	W	140-200	1 44	—	—	—	—	—	—	—

3. BOTTOM CHARACTER PROTRACTED FROM CHART No. 145.

The signs on the chart No. 145 are protracted in Fig. 2. a. There, *R*—means rocky bottom; *G*—Gravel and coarse sand; *S*—sand and fine sand; *M*—Mud and clay. Rocks are distributed along the banks and around the island, whereas gravels are distributed on the flat plains of the banks and islands as well as on the continental shelf. At the mouth of Nezugaseki^(s) there exists a rocky bottom at the depth of 60 m., though the shallower part of the flat floor has a sandy bottom. Another abnormal distribution of bottom materials is seen at the mouth of Port Sakata; there the gravels are distributed at the depth of 50 m., while the shallower sea floor is occupied by a sandy bottom. Such abnormal distribution of bottom materials is also recognized on the sea floor west of Tugaru Strait^(t).

Sand. Sand is distributed on the shallow sea bottom along the mainland, on the flat plains of the banks and islands. A noticeable fact in the distribution of sand is that the materials such as clay or mud are distributed on the shallower floor, while sandy bottom is found in the deep trenches lying between the continental shelf and banks or islands, and on the steep continental slope.

Mud. The sea floor below 200 m. in depth shows a muddy bottom without exception. Mud and clay are also distributed in the central region of the flat plains on the tops of the banks or around the islands as well as in the central area of the continental shelf and in the estuaries fed by large rivers.

4. SOUNDINGS FROM THE BANKS AND THEIR ENVIRONS.

The bottom materials dredged by the *Sôyô-maru* were dried and preserved in wooden boxes. The quantities of bottom materials dredged from different stations are different but in the majority of cases they are sufficient to fill a 10 cm³. box. Those materials were first sieved through 2 mm. mesh before examination. Characteristics observed under the microscope are given in Table IV.

a. *Rock fragments.* Rock fragments were dredged from 9 stations on the banks (average distance from the land, 49.54 km., average depth 193.8 m.), and 3 stations on the submarine platform near the islands (average distance 19.8 km., average depth 208 m.). Among the rock frag-

(s) 鼠ヶ關 (t) 津輕海峽

Table IV. The proportions of the materials in the dredged samples.

A, abundant in quantity; M, medium; S, small; R, rare.

Station number	Rock fragment		Gravel		Coarse sand	Fine sand	Mud	Organic remain										Remark
								Shell			Cal. algae	Foraminifera	Sponge spicule	Diatom	Abundant organic remain			
	large	small	large	small				shell	boring shell	shell fragment								
600	—	—	A	—	S	—	—	A	—	A	A	×	×	—	Sponge	Carcharodon sp.		
601	A	M	A	—	S	S	—	—	—	—	—	—	×	×	Sponge			
602	—	A	A	—	S	—	—	A	—	S	—	—	—	—	Bryozoa			
603	—	A	—	S	—	—	A	A	×	—	—	—	—	—	Belmetus Sponge			
604	—	—	—	—	—	A	A	—	—	—	—	×	×	×	Sponge	Brachiopoda Bryozoa Echinoid Bryozoa		
605	A	A	M	S	S	S	—	S	×	S	—	×	×	—	—			
606	A	A	—	R	R	—	—	A	×	S	—	—	×	—	—			
607	A	—	—	R	—	S	—	A	×	R	A	—	×	×	—			
608	—	R	—	R	—	—	—	A	×	—	—	×	—	—	—	Brachiopoda Sponge		
609	A	—	—	—	—	—	—	—	—	—	S	—	—	—	—			
610	—	A	S	S	—	S	—	A	×	S	R	×	×	×	—			
611	—	—	—	—	—	A	—	A	—	R	R	—	×	×	—			
612	—	—	—	R	A	M	S	S	—	R	R	—	×	×	—	Brachiopoda Coral Brachiopoda Bryozoa		
613	—	—	—	—	—	A	M	S	—	R	—	×	×	×	—			
614	—	—	—	—	—	A	A	—	—	—	—	—	×	×	—			
215	—	—	—	—	—	A	A	—	—	—	—	×	×	×	—			
616	—	—	S	A	A	S	—	A	—	S	—	×	×	×	—	Brachiopoda Coral Brachiopoda Bryozoa		
617	—	—	—	S	S	A	M	A	—	S	—	×	—	—	—			
619	—	M	A	M	—	S	S	A	×	S	—	×	×	—	—			
620	A	M	M	—	—	S	—	A	×	S	—	×	×	×	—			
621	—	—	—	—	—	S	A	—	—	—	—	—	×	×	—	Brachiopoda Bryozoa		
622	—	—	—	—	—	S	A	S	—	R	—	—	×	×	—			
623	—	—	—	—	—	S	A	—	—	—	—	×	×	×	—			
624	—	—	—	—	—	S	A	—	—	—	—	—	—	—	—			
625	—	—	—	—	—	A	—	R	—	R	—	—	—	—	—	Brachiopoda Bryozoa		
626	—	—	—	—	—	A	A	S	—	—	—	×	×	—	—			
628	A	—	M	—	A	—	—	R	—	R	—	×	×	×	—			
629	—	—	A	M	A	A	—	S	—	R	—	×	×	×	—			
630	A	—	M	—	R	—	—	—	—	R	—	—	×	—	—	Brachiopoda Bryozoa		





Fig. 2. The bottom character protracted from chart No. 145. (contour interval 20m.)

R....Rock. G....Gravel and coarse sand. S....Sand and fine sand.
 M....Mud and clay.

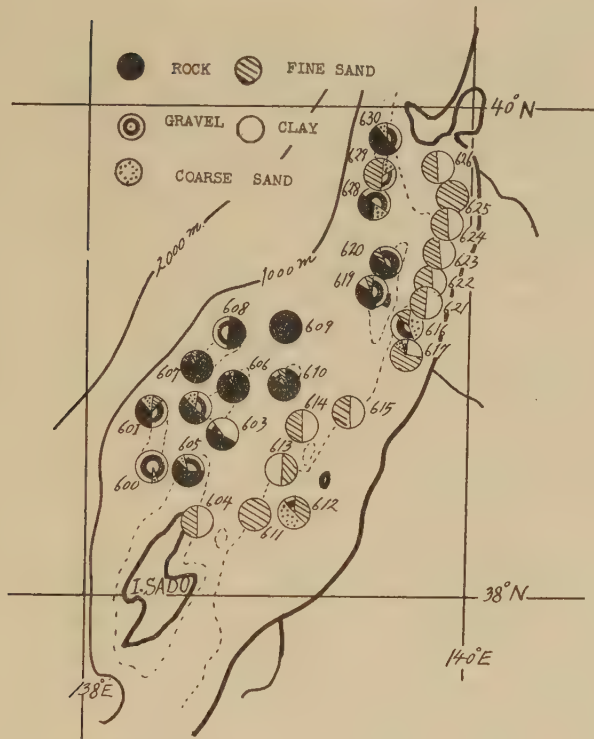


Fig. 3. Diagrammatic map showing the proportion of bottom materials in each station.

ments, those of diatom-earth are most common, followed by those of calcareous shale and fine sandstone. A few fragments are composed of layers of diatom-earth, fine sandstone, and pumice containing well water-worn pebble. Fragments of volcanic rocks were found from only two stations.

The diatom-earth is grayish-white in colour, soft and compact but easily crushable. The holes bored by shells are common on soft rock fragments, sometimes being filled with sand, gravels or minute rock fragments. The largest rock fragment is 16 cm. in length and 370 gr. in weight. Microscopic examination reveals that it is composed of well-preserved tests of diatoms, sponge spicules and tests of foraminifera mixed with mineral matters. Though specific determination of these diatoms are beyond the scope of the present article, abundance of the species belonging to the genus *Coscinodiscus* is remarkable, thus certifying that it is of marine origin.

Calcareous shale is also very common among the dredged rock fragments. It is very hard and compact. The holes bored by boring organisms are very abundant, sometimes giving a network-like aspect. Organisms such as bryozoa, brachiopoda, sponge, etc. are found attached on the upper surface which was exposed to the sea water, whereas not a single trace of them was found on the opposite side. The broken surface of the fragment of this kind shows that a thin brown-coloured crust is developed on the surface, the interior being grayish white in colour. Under the microscope, tests of foraminifera, diatoms, and sponge spicules are found cemented by calcite or aragonite sometimes mingled with quartz grains. The largest fragment is 19 cm. in length, and 150 gr. in weight.

Fragments of soft sandstone were dredged from the stations Nos. 601 and 606, they resemble the diatom earth in colour but are much harder. Those dredged from the station No. 606 contain many indeterminate species of fossil foraminifera.

Small fragments of liparite, quartz-porphry and basalt were dredged from the stations Nos. 601, 602, and 619. A fragment of quartz-porphry dredged from the station No. 600 is rhombus-shaped with a layer of mineral matters on the margin as shown in Plate IV., fig. 3. a. It seems that this rock fragment lay partly submerged in a muddy bottom on the sea floor, for organisms were attached on only one side.

The stations where many kinds of rocks fragments were dredged are situated on the flatplains of the banks or around the islands. These banks or islands rise from the deep sea floor along the outer margin of the continental shelf of North-east Japan, separated by a trench with a depth more than 300 m., so that transportation of rock fragments and gravels from the mainland or from one bank to another is impossible. Furthermore, it is also impossible that such loose materials as diatom-earth or soft sandstone are liable to be transported to any great distance by the action of currents or waves at such a depth. It seems therefore that these rock fragments are pieces crushed out from the bed rocks of the banks or the islands.

The rocks represented by the dredged fragments are found in the geological elements making up the Neogene Tertiary of the adjacent districts. The diatom-earth is commonly found in the Neogene Tertiary Formation of North-east Japan, as in the Pliocene Sawane Formation⁽¹⁾ developed in Sado Island, the Pliocene Wakimoto Sandstone of the Neogene Yuri⁽²⁾ Series in the Akita oil field, the Miocene Funagawa

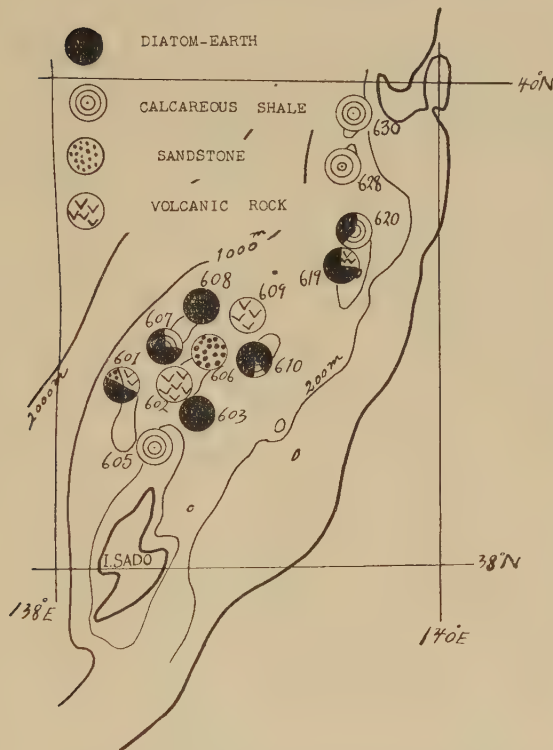


Fig. 4. Diagrammatic map showing proportion of quantities and kinds of dredged rocks in each station.

Black Shale in Oga Peninsula⁽²⁰⁾, etc. Calcareous shale containing marly nodules is also a characteristic member of the Tertiary Formation of the oil fields of Akita, Yamagata and Niigata and is associated with beds of diatom-earth. Thus, though the fossil diatoms and other fossil organisms in the rock fragments dredged by the Sôyô-maru are of little value for accurate correlation of the rock strata, yet it should not be overlooked that the general characters of the fragments in question closely resemble those of the Tertiary^(2, 8, 7) rocks of the adjoining oil fields. Liparite, quartz-porphry and basalt are found commonly in the Tertiary or Quaternary Formation of the oil fields.

From the attachment of organisms on one side only of the rock fragments and the existence of bored holes on them filled with gravels or sand, it is evident that the bed rocks are naked in some places on the banks, and covered by a thin layer of sand or gravel in other places.

Table V. General features of the rock fragments dredged from the flatplains on the Banks and the Islands.

Dredge-station of rock fragment				Kind of rock				Measurement of the largest rock fragment				Surface character		
Station number	Position	Depth in meters	Distance from land	Diatom-earth	Soft sandstone	Calcareous shale	Igneous rock	Length	Width	Thickness	Weight	Surface	Hole of boring shell	Adhesion of organisms
601	Bank	m. 454	49.6	..	..	..	A	cm. 13.4	cm. 7.0	cm. 3.4	gr. 205	Smooth	-	+
"	"	"	"	..	R			6.2	4.8	4.4	40	Irregular	-	+
"	"	"	"	A				8.0	6.7	6.0	96	Irr.	+	-
602	Bank	205	50.5	..	..	..	A	7.0	9.4	2.2	72	Irr.	-	+
603	Bank	210	43.0	A				3.6	2.7	1.5	80	Irr.	+	-
605	Island	139	19.0	..	..	A		16.0	9.6	6.6	1040	Irr.	+	+
606	Bank	117	59.4	..	A			13.0	10.0	4.2	394	Irr.	+	-
607	Bank	165	69.6	A				16.0	9.2	6.7	370	Irr.	+	+
"	"	"	"	..	..	C		12.0	11.0	5.6	525	Irr.	+	+
608	Bank	150	89.9	R				3.9	1.8	0.8	2	Irr.	-	-
609	Open Sea	667	47.4	..	..	..	C	3.0	1.9	1.6	13.1	Irr.	-	-
610	Bank	145	47.0	A				4.7	3.0	2.8	14	Irr.	+	+
"	"	"	"	..	..	R		2.8	1.7	0.7	5	Sm.	-	-
619	Island	333	9.6	A				7.7	3.7	3.3	60	Sm.	+	+
"	"	"	"	..	..	..	R	6.0	5.1	5.0	125	Irr.	-	-
620	Island	139	30.0	..	..	A		19.0	15.5	9.0	1495	Irr.	+	+
"	"	"	"	C				4.6	4.1	3.1	15	Irr.	+	-
623	Bank	148	29.4	..	..	A		16.0	15.8	6.8	2150	Irr.	+	-
630	Bank	150	12.5	..	..	A		13.7	12.0	4.9	1050	Irr.	+	-

A, abundant C, common R, rare

Table VI. Measurements of the largest pebble from each station.

Station number	Position	Depth in meters	Distance from land	Kinds of associated gravels	Kind of the measured pebble	Weight	Length	Width	Thickness	Shape	Surface	Adhesion of organism
600	Bank	168 ^{m.}	28.3 ^{km.}	Ba. Sh. Gr.	Ba.	32.8 ^{gr.}	5.0 ^{cm.}	3.5 ^{cm.}	2.5 ^{cm.}	Sub A	P	+
601	Bank	454	49.6	Lip. Sh.	Sh.	94.0	6.0	4.5	2.5	F.R	Sm.	-
602	Bank	205	50.5	Q-And. Lip. Sh. Q-Porph.	Q-And.	15.50	9.0	5.6	2.5	F.R	Sm.	-
603	Bank	210	43.0	Lip. Ch. And.	Lip.	15.0	4.0	3.8	1.1	Sub A	irr	-
605	Island	139	19.2	Tuff. Sh. And.	And.	30.0	2.5	2.0	1.8	Sub A	Sm.	-
606	Bank	117	59.4	Tuffaceous SS. Grey.	Grey.	19.6	9.0	5.0	2.7	R	Sm.	+
607	Bank	165	69.6	Lo se Sh. Tuff.	Loose Sh.	17.0	6.0	6.0	4.0	R	P	+
608	Bank	150	84.9	Sh.	Sh.	1.0	2.0	1.5	0.8	Sub A	P	-
610	Bank	145	56.2	Calcareous Sh. Grey. L p. And.	And.	75.0	5.5	2.8	2.5	A	Irr	-
612	Main land	112	28.9	Sh. Q.	Sh.	0.5	1.2	0.6	0.2	R	Sm.	-
616	Main land	106	12.6	Grey. Lip. And. SS.	Lip.	50.0	2.0	1.7	0.7	R	Sm.	-
617	Main land	106	17.1	Grey. Ch. Sh. Lip. Gr.	Lip.	18.1	2.2	2.2	1.3	Sub A	Sm.	-
619	Island	338	35.1	Ba. Ch. And. Sh. Conglo.	Ba.	23.1	8.0	6.5	4.5	R	P	-
620	Island	139	30.1	Sh. Lip. Ba.	And.	17.8	7.0	6.0	3.3	Sub A	P	-
628	Bank	148	29.4	Sh.	Sh.	30.0	5.5	4.5	3.0	R	Sm.	-
629	Bank	247	23.5	Sh. Q. Ba.	Ba.	49.7	5.0	4.0	2.2	R	Sm.	-
630	Bank	150	12.5	Grey. Q-Porph. Ba. Lip. Sh.	Grey.	2.7	5.5	4.5	2.0	R	Sm.	-

Ba.....basalt Sh.....shale A. angular Sm....smooth
And. andesite Ch. chert Sub. A..subangular P.....porous
Q-And....quartz- Grey. ..greywacke- R. round Irr....irregular
 andesite sandstone F. flat
Q-porph. ..quartz- Conglo...conglomerate
 porphyry Q.....quartzite
Lip. liparite SS. sandstone
Gr.: granite

		Depth	Distance from land	Weight
Average	On the Banks	205.3 ^{m.}	46.54 ^{km.}	34.88 ^{gr.}
	Around the Island	205.3	28.13	23.63
	On the continental shelf	118.0	19.53	22.86

It is still uncertain whether the holes on the rock fragments were bored by organisms at the present depth or they were made in a shallower sea before the banks attained such a depth.

b. *Gravels*. Gravels were dredged from the banks and on the flat plains around the island as well as on the continental shelf along the mainland. Gravels were dredged at seven stations on the banks (average depth 205 m., average distance from land 46.54 km.), three stations on the submarine platform around the islands (average depth 187.77 m., average distance 28.13 km.), and from three stations on the continental shelf (average depth 108 m., average distance 19.54 km.). It is noteworthy that those from the banks are far larger in size than those from the continental shelf and their surface is coloured brown by mineral matters, while those from the continental shelf show a well-polished and unstained surface. Hard pebbles dredged from the banks are well water-worn and bear no markings on the surface, while soft ones such as of shale or soft sandstone frequently bear holes bored by molluscs. They are only rarely encrusted with such organisms as calcareous algae, bryozoa, sponge, etc. Table VI shows the measurements of sizes, weights, shapes, and other aspects of the largest gravels dredged from some stations.

Of the gravels collected, one hundred were arbitrarily selected for petrographical study. As shown in Table VII, they are classified into three groups, i. e., sedimentary, igneous, and pyroclastic rocks. The most abundant are the soft rocks which most probably belong to the Neogene Tertiary, extensively developed in the adjacent districts, and comprise shale and sandy shale, containing fossil diatoms, foraminifera and sponge spicules and closely resembling in character the bed rocks dredged from banks.

Besides, there are some hard sedimentary rocks such as quartzite, hornstone, greywacke sandstone, and metamorphosed sandy shale. They are found among the gravels dredged from the banks, suggesting that they were derived from the Tertiary conglomerate beds which contain abundant pebbles of the Palaeozoic sedimentary rocks. Those rocks do not contain fossils, but such kinds of rocks are common members of the Palaeozoic System developed in North-east Japan. Pyroclastic rocks are liparitic and basaltic tuffs; they are associated with volcanic rocks in the Tertiary or Quaternary System of the adjacent districts.

Igneous rocks are classified into volcanic and hypabyssal rocks. Volcanic rocks are very common in the gravels, and comprise basalt,

Table VII. Kinds of the gravels dredged from the banks and their environs, as determined under the mineralogical microscope.

Kind of rock		Station number
Sedimentary rock	Kind of rock (younger)	600
	Soft rock (older)	601
Pyroclastic rock	Kind of rock (younger)	602
	Hard rock (older)	603
Igneous rock	Kind of rock (younger)	604
	Hard rock (older)	605

quartz-porphyry, andesite, liparite and andesitic pumice. Such rocks are very frequently found in the Tertiary and Quaternary Systems of the oil-fields of this district. The gravels of hypabyssal rocks are only rarely found among the samples, and comprise granite-porphyry and augite-porphyrity. These are also found in the Tertiary and Pre-Tertiary Systems of this district.

Thus, judging from the lithological characters of the gravels, they seem to have been derived from the Tertiary System of this region.

c. *Sand*. A small quantity of sand was collected at every sounding station; but only a few stations on the banks produced the material sufficient for physical analysis. The sand was first sieved through a 2 mm. mesh and then divided into four classes by means of the A. S. K. elutriator, as shown in Table VIII.

It is reasonable that large sized grains are abundant in the sand associated with gravels, but it is strange that very coarse sand was dredged from the continental slope, and fine sand was taken from the continental shelf. Sand grains consist of quartz, feldspar, coloured minerals, garnet, foraminifera, sponge spicules, diatoms, etc.

For the purpose of calculating the abraide percentage of sand grains by Tester's method⁽³¹⁾, quartz grains of 0.5 mm. in diameter were gathered from each station, and were washed with dilute hydrochloric acid before examination. The results of calculation shows that the abraide percentage of the sand grains on the banks and the islands is great, St. No. 600 (63%), 601 (60.9%), 605 (58.3%), 606 (50.7%), 607 (55.9%), 610 (68.9%), 628 (54.7%), 630 (71.3%), average 61.09% (sub-round class according to Tester), while that of sand grains from the continental shelf and slope is small, St. No. 611 (52.2%), 613 (48.1%), 612 (39.1%), 616 (38.7%), 607 (34.7%), average 42.6% (angular class according to Tester). It is a very interesting fact that the abraide percentage of the sand grains dredged from the flatplains on the banks and the islands is far greater than that of those from the continental shelf and slope. This fact together with the characteristics of the dredged gravels, suggests that remarkable difference of geological conditions existed between the banks or islands and the continental shelf when deposition was taking place.

d. *Organisms*. Organic remains found in the dredged samples comprise corals, bryozoa, sponge spicules, brachiopoda, foraminifera, mollusca, etc., the most abundant being molluscan remains. The kinds of shells are 54 in number but only 44 species were determinable (33

Table VIII. Size grades of sands dredged from the banks and their environs.

Station number	Depth in meters	Distance from land	2-0.25 ^{m.m.} coarse sand	0.25-0.1 ^{m.m.} fine sand	0.1-0.05 ^{m.m.} silt	0.05 ^{m.m.} clay
	m.	km.	%	%	%	%
604	444	12.8	10.52	41.92	21.54	26.02
611	143	29.4	49.08	33.13	7.30	10.49
612	112	12.5	58.08	11.58	8.73	21.61
613	254	19.0	8.82	39.17	17.43	34.58
614	510	26.5	—	1.68	12.41	85.91
615	439	31.6	—	2.39	12.27	85.34
616	106	12.6	40.69	20.54	7.47	31.30
617	106	17.1	35.43	38.78	4.97	20.82
621	93	7.6	—	16.30	31.30	52.40
622	218	15.5	—	8.55	32.24	59.21
623	93	14.5	—	3.61	33.40	62.99
624	73	15.0	—	7.46	42.88	49.66
625	51	11.5	—	80.38	12.15	7.47
626	70	9.6	—	25.48	43.88	30.64
628	148	29.4	50.25	37.01	2.6	10.14
629	247	23.5	59.91	21.68	4.88	13.53

species of Pelecypoda, 1 species of Scaphopoda, 10 species of Gastropoda). These molluscs were identified by Mr. S. Nomura, and are listed in Table IX. A large number of shells were found from 12 stations (average depth 150 m.) and a small one from 6 stations (average depth 140 m.). The preservation of the shells is very good but whether they are fossils or not is yet unsettled. On comparison of the molluscan fauna of this region with those dredged from the same depth in the Korean Strait and West Tugaru Strait, it is found that the majority of the northern types are common to the three regions, but about the half of the temperate types are recorded for the first time in this region. In 1931, Messrs. T. Kuroda and K. Kikuti^(c.n) published a paper on the distribution of the molluscan fauna in the Toyama Bay, pointing out three faunal zones according to the depths. The molluscan fauna of this district closely coincides with that of the deepest zone in the Toyama Bay.

The following table is a comparison of the molluscan faunas dredged in the Korean Strait, West Tugaru Strait and this region.

	Molluscs in the dredged materials.	Common to Korean Strait and this region.	Common to West Tuguru Strait and this region.	Common to Korean Strait, West Tuguru Strait and this region.	This region only.
44 sp.	Cold (northern) type 24 sp.	17 sp.	12 sp.	6 sp.	2 sp.
	Temperate type 16 sp.	9 sp.	4 sp.	4 sp.	7 sp.
	Warm (southern) type 4 sp.	3 sp.	1 sp.	1 sp.	1 sp.

Shells of boring mollusca were dredged from eight stations and rock fragments with holes bored by them were got from two stations, the average depth of those stations being 170.2 m. It is uncertain whether the boring molluscs actually live at such a depth, or they lived on a subsiding bottom.

Besides the molluscan remains, bryozoa, brachiopoda, corals, calcareous algae were dredged from the stations below 100 m. It is questionable whether those organisms are actually living at those stations or not, their soft parts being lacking. They may be fossils or semi-fossils, but the mammalian bone and *Carcharodon* sp. dredged from Station No. 601 should be considered as fossils.

e. *Relation between Topography and Bottom Deposits.* The results of sounding by the *Sôyô-maru* show close coincidence with the bottom characters shown in chart No. 145, except that there are a few places shown as muddy bottom, where gravels and sand were dredged by the *Sôyô-maru*.

The rocky bottom is distributed on the shallow sea floor along the shore cliffs, on the banks and around the islands. As an exception, on the flat sea floor, in the openings of Murakami, at the depth of 40 m.-60 m., the rocky floor is developed though the shallower portion is occupied by a sandy bottom. From the flat plains of the banks, many fragments of rocks were collected mixed with gravels and sands. On the surface of the dredged rock fragments were found holes bored by boring mollusca, the holes sometimes being filled with gravels and sands. This fact suggests that the bed rocks in some parts are covered by a thin layer of gravel and sand. Gravels are distributed on the tops of the banks and on the submarine platform around the islands. There is an abnormal distribution of gravels on the continental shelf off Port Sakata where the gravels spread out on the deep sea floor regardless of the fact that the shallower bottoms are occupied by sand. Sand is

distributed on the banks, flatplains around the islands and continental shelf. It is very interesting to find that bottoms of the trenches between the submarine elevations and continental shelf consist of sand, whereas the muddy bottom spreads on the shallower floor of the continental shelf. Mud is distributed on the deep sea floor below 200 m., also on the estuaries fed by large rivers, as well as in the central portion of the flat plains on the banks and on those around the islands.

5. SUMMARY AND CONCLUSIONS.

Many banks and islands are found on the floor of the Japan Sea between the Oga Peninsula and Sado Island. They are arranged in the NE-SW direction, being separated by a deep trough from the continental shelf along the mainland of Japan. The tops of the banks are very flat at the depth of 140 m.-160 m. below sea level. There exist also flat plains of the same depth around the islands, this depth coinciding with that of the lower limit of the flat plain on the continental shelf.

The Surveying Ship *Sôyô-maru* of the Imperial Fisheries Experimental Station dredged many bottom materials from the banks, the flat plains around the islands and the continental shelf of this region. Judging from the lithological characters of the rock fragments dredged, the bed rocks of the banks belong to the Neogene Tertiary which is developed in the oil fields of North-east Japan.

The bed rocks seem in some places to be naked, and in other places to be covered by a thin layer of sand or gravel. The gravels dredged from the banks are well water-worn, their lithological characters also suggesting that they were derived from the Tertiary system of this district.

From the above mentioned facts, the banks as a whole represent a recently submerged land block which has a close relation geologically as well as topographically to the main land of North-east Japan. But the problems concerning the tectonics and geological cycles of the banks, islands and continental shelf are open for future investigations. Those problems may be solved after a full investigation of the present conditions of the sub-aerial region of this district.

In conclusion the writer wishes to express his sincere thanks to Prof. Dr. T. Kato for his kind help and criticism. He is also grateful to Mr. S. Nomura for his kind guidance in determination of mollusca and also to Mr. Hatai for his kind help.

[illegible]

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Plate IV

Fig. 1. Gravels dredged from the station No. 600.

- a, b. Calcareous algae attached on the gravel.
- c, d. Subangular gravels of andesite.
- e. Gravel of basalt.

Fig. 2. Rock fragments dredged from the station No. 606.

- a. Rock fragments of fine sandstone bored by boring mollusca.

Fig. 3. Rock fragment, gravels, mammalian bone dredged from the station No. 601.

- a. Mammalian bone.
- b. Gravel of shale.
- c, d. Gravels of basalt.
- e. A fragment of quartz-porphry. On the margin of Fig. 3. a, and e, there is precipitated a layer of mineral matters. It seems that these materials lay partly submerged in the muddy bottom on the sea floor, for organisms were found attached on one side only.

Fig. 1

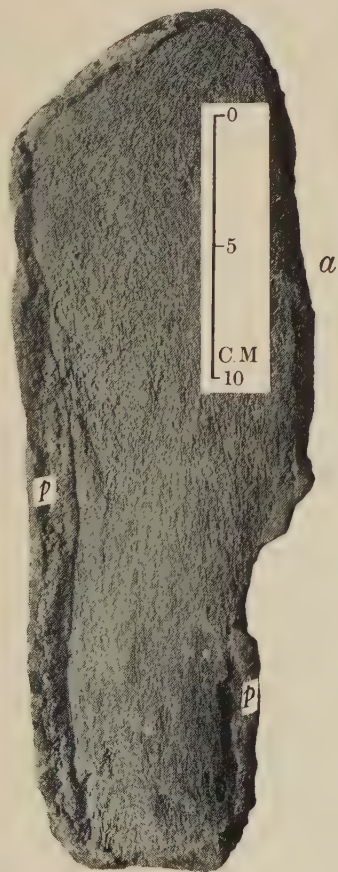
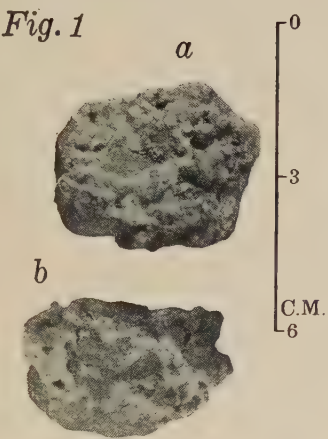


Fig. 2

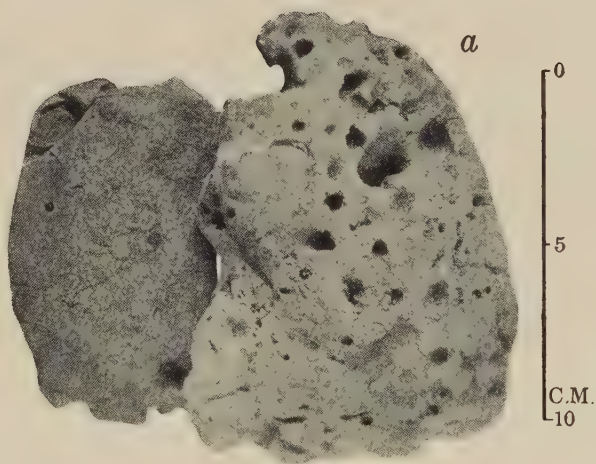


Fig. 3

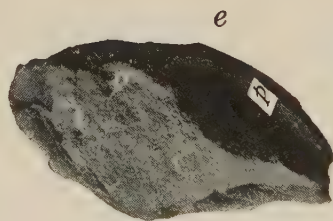
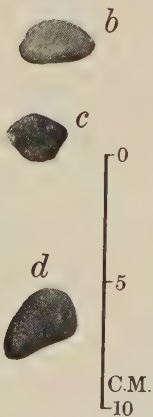


Plate V

Fig. 1. A rock fragment and gravels dredged from the station No. 605.

- a. A fragment of calcareous shale, hard and well stratified. There are many organisms attached on one side, exposed in water and bored by boring organisms.
- b. Photomicrograph of the rock fragment shown in Plate V, Fig. 1. a. ($\times 240$). Tests of diatoms and foraminifera are well preserved.
- c, d, e. Gravels of calcareous shale.

Fig. 2. Gravels and rock fragments dredged from the station No. 630.

- a. A fragment of calcareous shale. Bryozoa attached on the surface, bored by boring organisms.
- b. Gravel of liparite.
- c. Gravel of basalt.
- d. Bryozoa attached on the surface of liparite gravel.
- e, f. Calcareous nodules which resemble a gravel.
e shows a broken surface of f. (Note a radial structure)

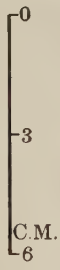
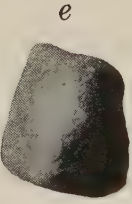
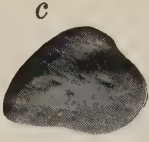
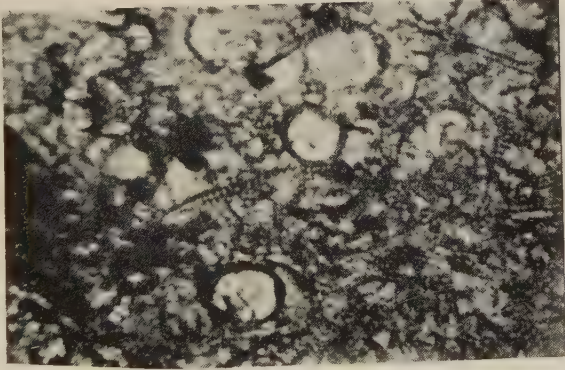
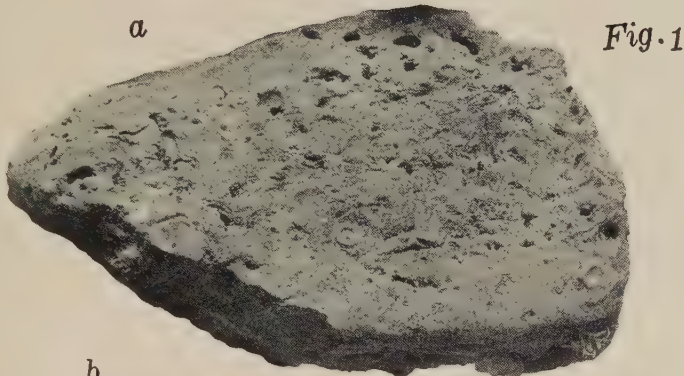


Fig. 2

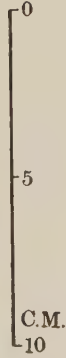
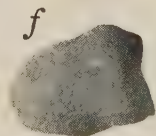
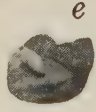
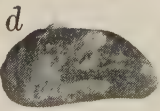
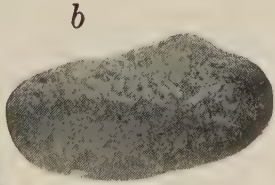


Plate VI

Fig. 1. Rock fragment dredged from the station No. 607.

- a. A fragment of calcareous shale. The surface shows a net-work appearance owing to the presence of numerous holes made by boring shells. Many other organisms are also attached on the surface.
× : broken surface.
- b. Photomicrograph of Fig. 1. a.
Fossil *Coscinodiscus* sp. (× 250).
- c. Diatom-earth.

Fig. 2. Gravels and rock fragments dredged from the station No. 610.

- a. A fragment of diatom-earth.
- b. A gravel of quartz-porphry.
- c. A gravel of greywacke sandstone.
- d, e. Gravel of calcareous shale.
- f. *Vermetus* attached on the shell of *Hiatella arctica*.
- g. A small nodule which seems derived from calcareous shale.

Fig. 1

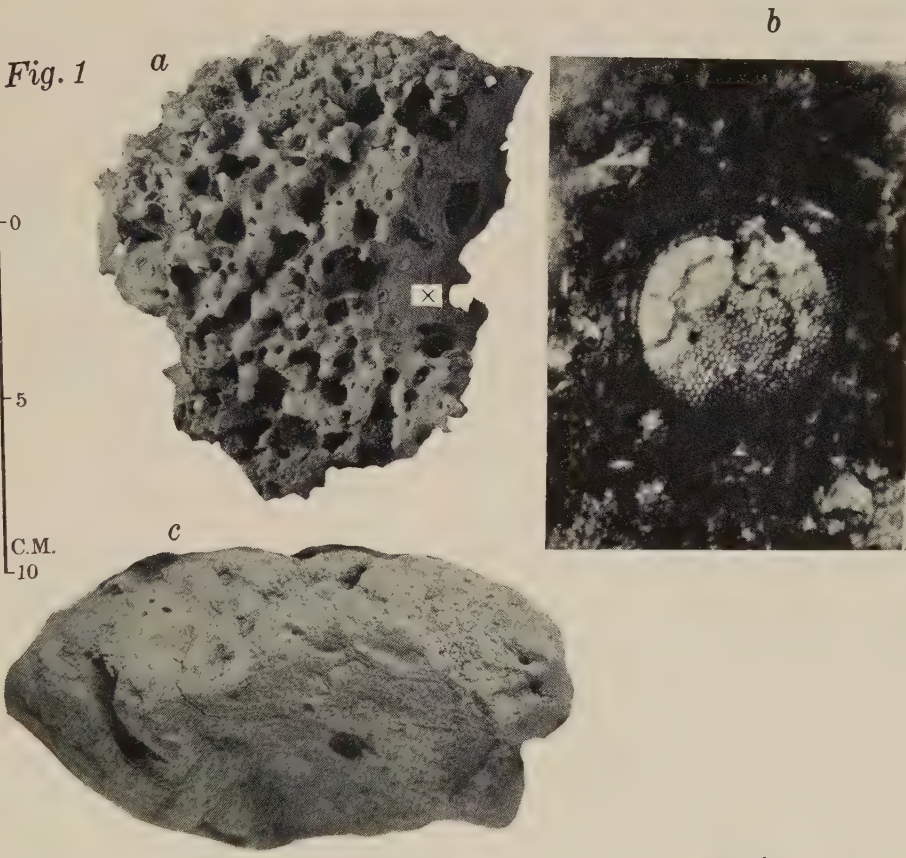


Fig. 2

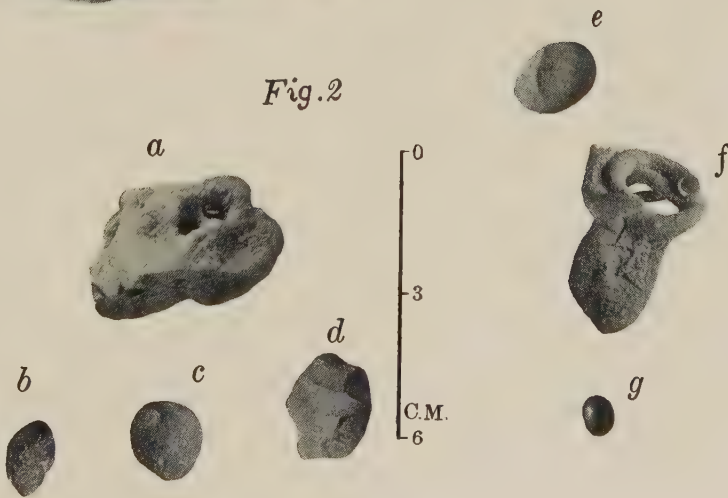


Plate VII

Fig. 1. Gravels and rock fragments dredged from the station No. 620.

- a, c. Fragment of calcareous shale. $\times$: broken surface.
- b. Gravel of basalt.
- d. Gravel of calcareous shale.

Fig. 2. A rock fragment and a nodule dredged from the station No. 628.

- a. Fragment of calcareous shale, with holes made by boring organisms and filled with coarse sand.
- b. Photomicrograph of the rock fragment (Fig. 2. a), showing a test of foraminifera ($\times 190$).
- c. Calcareous nodule.

Fig.1

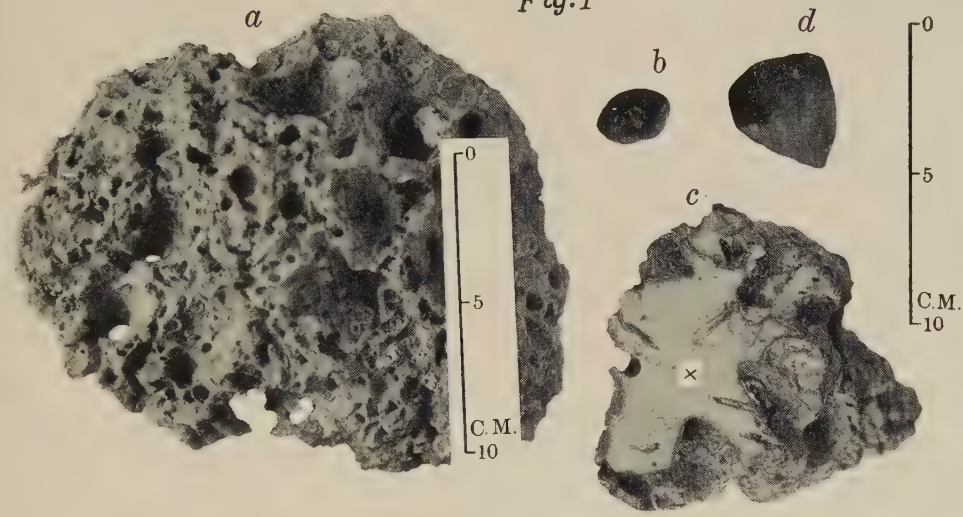
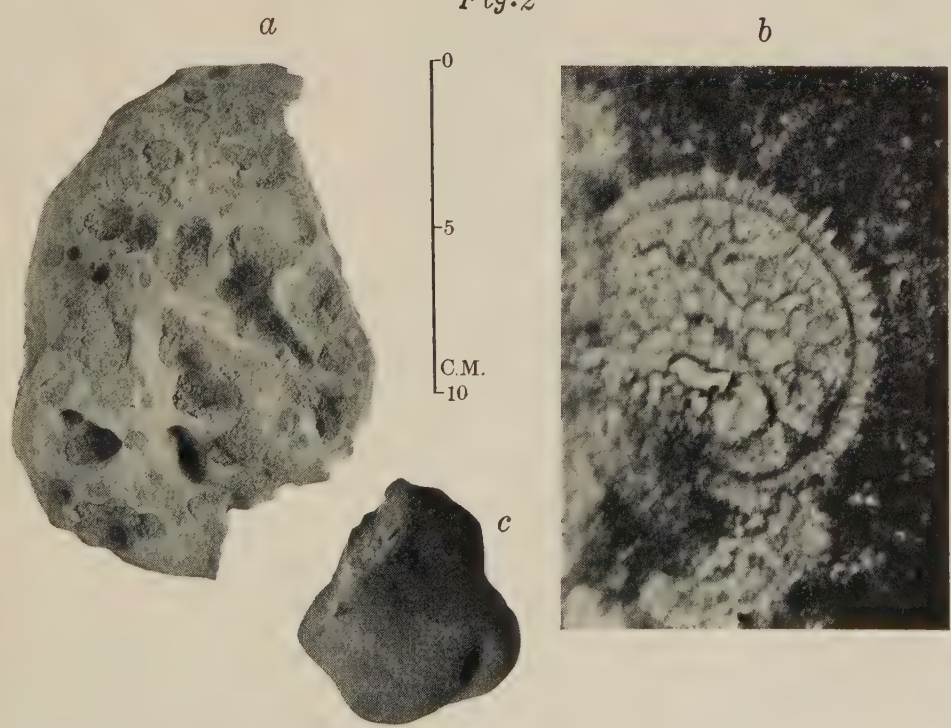


Fig.2



On the Development of Some Marine Bivalves, with Special Reference to the Shelled Larvae. II.*

ITIRÔ MIYAZAKI

(Received Jan 16, 1936)

VI. *Macra sulcataria* REEVE (Pl. VIII)

This mollusc occurs abundantly along the Pacific coast of the southern part of the Main Island of Japan and is one of the most important shell-fishes of our country. The breeding season lasts from late April to late autumn in the vicinity of Tokyo Bay.

Ovum assumes a pear-shaped form when freshly laid; but it soon changes to a globular one with its diameter ca. 55μ long and a jelly coating 12μ thick. The germinal vesicle which is 30μ in diameter contains a large and a small nucleoli.

Spermatozoon is very motile when fresh from the testis; its head is conical in form and the middle pieces consist of several chondriospheres.

The artificial fertilization, which is very easy to be performed, gives rise to a series of developmental stages as shown in the figures. The polar lobe is not to be seen (Figs. 1~5). At the time the entoblastic cells are 8 in number, the embryo begins to rotate in the seawater by means of fine cilia. The apical cilia are rather conspicuous at earlier stages but they can be no longer made out in shelled larvae (Figs. 6~12). Young shelled larvae which still abundantly contain yolk granules measure about 80μ in length, 66μ in height, and 54μ along the hinge line (Fig. 13). When the shell is ca. 93μ long and 78μ high, its growth-lines are distinctly observable. At this stage the colour of the shell is mostly light yellow, and deeply yellow along its margin but purple along the hinge; yellowish liver is seen through (Fig. 14). The asymmetry of the outline is obvious in the shell which is ca. 132μ long, the posterior end of the shell being more strongly

* In the first instalment, the specific name should be corrected as *Mytilus edulis* LINNÉ.

curved than the anterior one (Figs. 15~16). Fig. 17 represents a shell ca. 140μ in length with its umbo beginning to project. Teeth are seen along the hinge of the shell which assumes a much depressed oval form and measures ca. 163μ in length. Statocyst is clearly made out (Figs. 19~20). The largest form raised by the writer measures about 177μ in length and 166μ in height (Fig. 21).

Eye-spot which is seen in larvae of *Anomia*, *Mytilus* and *Ostrea* is not present in the present form.

VII. *Mactra veneriformis* REEVE.
forma zonata LISCHKE (Pl. IX)

The present lamellibranch is as useful as *Mactra sulcataria* in supplying food-stuff in our country. It bears also close resemblance to the latter in its distribution, breeding habits, and earlier developmental stages.

The young shelled larva as is represented in Fig. 1 is still rich in yolk, measuring 84μ in length, 68μ in height and 57μ along the straight, faintly purple hinge. The apical cilia are no more to be seen.

Nearly all the yolk granules are consumed by the time the shell attains a length of about 90μ and a height of 77μ . The growth-lines of the shell are now distinct (Figs. 2 and 3).

At the time the shell is ca. 133μ long and 113μ high, its anterior and posterior curvatures differ considerably.

When the shell is ca. 153μ in length, it is mostly yellow in colour but the hinge is purple and the liver lobes rather deep yellow. The umbo commences now to project (Figs. 4~6).

A slight flattening of the shell is evident when it is ca. 277μ long and 206μ high, its posterior end more protruding than the anterior one. At this stage the gill filaments, 3 in number, are definitely laid down, the siphon is present, and the foot conspicuously large; but the velum completely disappears (Figs. 9. and 10). From this time on the young leads a bottom life.

The largest form raised by the writer is a young spat which is shown in Fig. 11. It measures ca. 403μ in length, 354μ in height. The light yellowish prodissoconch colouration of the shell has become fainter; the umbonal region is dark blue, and the liver brown in colour. The gill filaments amount to 5 in number. The heart is seen actively pulsating. The eye-spot is absent as reported by Kändler in European species of *Mactra*.

Up to this stage the similarity between the larvae of the lamelli-branch in question and those of *Macra sulcataria* is so marked that the discrimination of the former from the latter is not very easy.

VIII. *Mysella japonica* (YOKOYAMA). (Pl. X)

Just like the other species of the family Montacutidae the present species undergoes earlier developmental changes in the gill chamber which serves as the brood pouch.

The advanced embryo at the time of freeing from the mother shell into the surrounding medium is elliptical in outline and measures about 124μ in length, 95μ in height, and 72μ along the straight hinge line. The shell is almost colourless except the light purple hinge, and so transparent that the apical cilia and rather deep yellow liver are clearly seen beneath it (Figs. 1 and 2).

The stage with the shell size ca. 160μ long and 133μ high is characterized by the appearance of the growth-lines and that of unequal curving of the anterior and posterior margins of the shell. The projection of the umbo is already manifest at the time the shell is somewhat oval in outline, measuring about 193μ in length and 167μ in height.

The colouration of the shell is, however, nearly the same as before (Figs. 3~5). Figures 6 and 7 show a slightly larger shell which is 306μ long and 280μ high.

The largest form raised by the writer is shown in Figs. 8 and 9, its dimensions being ca. 306μ in length and 280μ in height. It may be mentioned that Lovén could not rear the larvae of *Montacuta ferruginosa* and those of *M. bidentata* so large as those of the present species.

IX. *Paphia philippinarum* (ADAMS and REEVE.) (Pl. IV)

The widely distributed and much valued shell-fish, *Paphia philippinarum*, spawns in warm season. The season covers from April to October but the spawning act ceases during warmer months, viz., from late July to late August, near the Kanazawa Laboratory.

The intact egg freshly laid is covered with a jelly coating which is about 23μ in thickness. The maturation division just after the insemination is shown in Figs. 5 and 6.

It may be mentioned that the earlier development of this mollusc

up to the shell length ca. 133μ was already published by the writer (1934). The D-shaped larva which is a little more advanced than the one just referred to is characteristically provided with anteriorly much protruded shell which is mostly deep yellow in colour but the hinge is deep purple (Fig. 1.)

When the shell attains a size about 209μ in length and 196μ in height the umbo begins to project postero-dorsally. The foot is very large, the gill anlage distinct, and the teeth visible on the hinge line. The liver is greenish yellow or yellowish brown in colour (Fig. 2).

The decrease of the velum in size and increase of the foot in activity take place at the stage with the shell size ca. 227μ long and 221μ high (Fig. 3).

Fig. 4 represents a young spat, the shell of which is about 644μ long and 564μ high, and almost colourless except the faintly brownish posterior part and rather faintly purple umbo whence radiating striae run on the surface the of shell. Only the exhalent siphon is present at this stage; the greenish yellow liver is clearly seen, but the eye-spot is absent.

X. *Erycina* sp. (Pl. V)

This is a commensal bivalve and found attached on the ventral surface of the cephalothorax of a decapod crustacean, *Gebia major* de Haan (Text-fig. 1). Since its systematic position has not yet been worked out (Ohshima) it is provisionally furnished with the name *Erycina* sp. in the present report.

Four specimens of this lamellibranch were obtained on June 5, 1935 near the Kanazawa Laboratory. One of them was transferred to a Petri's dish in which it liberated numerous larvae.

The larvae were cultured for about 40 days with such minute organisms as *Chlorella*, navicula-like diatoms, etc.

Of the remaining three, two were dissected and sectioned. Both the two were found to contain numerous ovarian ova within the body, spermatozoa in receptaculum seminis, and young embryos in the gill chamber.



Text-fig. 1. *Gebia major* with *Erycina* sp. on the ventral surface of the cephalothorax.

Figs. 1 and 2 show the youngest embryo which the author could obtain from the gill chamber of the mother shell. At this stage the velum is not yet provided with cilia around it. The apical cilia are distinctly seen but they are not motile.

A little advanced embryo (Fig. 3), with its shell measuring 180μ long and 136μ high, is still devoid of swimming power although the velar cilia are beating.

At the time the shell attains a size ca. 220μ long, 170μ high, 110μ along the hinge line (Fig. 4) the larva seems to enter free-swimming life. In this larva the yolk granules are not present at all whereas the anterior adductor muscle and statocyst are well developed.

The shell is colourless except the hinge which is tinged with purple.

The yellow velum and liver stand out clearly in the otherwise colourless soft part.

The growth-lines of the shell and the posterior adductor muscle are visible when the shell is ca. 246μ long and 196μ high (Fig. 5).

The anterior end of the shell becomes much more swollen than the posterior one at the shell size ca. 273μ in length (Fig. 6).

The projection of the umbo begins and the gill anlage appears at the time the shell is ca. 327μ long and 280μ high (Fig. 7).

The stage with the shell size ca. 351μ in length and 298μ in height is characterized by marked development of the umbo, the degeneration of the velum and the enlargement of the foot (Fig. 8). The body is dirty yellow now but the umbonal region is purple and the liver greenish yellow.

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Explanation of Plates.

Pl. VIII. *Macra sulcataria*.

- Fig. 1. Appearance of the second polar body.
- Fig. 2. First cleavage.
- Fig. 3. Second cleavage.
- Fig. 4. 8-cell stage.
- Fig. 5. 16-cell stage.
- Fig. 6. Formation of 8 entoblastic cells.
- Fig. 7. A little later stage, at which embryo begins rotation.
- Fig. 8. Trochophore stage.
- Fig. 9. Later trochophore stage. Shell makes its appearance. Sh: Shell.
- Fig. 10. The same stage seen from apical side.
- Fig. 11. Young shelled larva.
- Fig. 12. The same stage viewed ventrally.
- Fig. 13. Shell is large enough to enclose nearly the whole body. Yolk granule is not yet absorbed completely.
- Fig. 14. } Growth-lines appear.
- Fig. 15. }
- Fig. 16. More advanced D-shaped larva. p.p: Portio pylorica; p.c: Portio cardiaca.
- Fig. 17. Early umbo-stage.
- Fig. 18. The same stage seen from left.
- Fig. 19. More advanced umbo-stage.
- Fig. 20. The same stage seen from left.

Fig. 21. Post-veliger stage

Pl. IX. *Macra veneriformis*.

- Fig. 1. Young D-shaped larva, ca. $84 \times 68 \times 57 \mu$.
 Figs. 2-3. Growth-line of shell visible. Shell ca. $90 \times 77 \times 57 \mu$.
 Fig. 4. More advanced stage, ca. $113 \times 103 \times 57 \mu$.
 Fig. 5. Shell ca. $133 \times 113 \times 57 \mu$.
 Fig. 6. Early umbo-stage. Shell ca. $153 \times 133 \mu$.
 Fig. 7. More advanced stage. Shell ca. $198 \times 177 \mu$.
 Fig. 8. The same stage seen from right.
 Fig. 9. Velum is cast off. Larva enters bottom life. Shell ca. $227 \times 206 \mu$.
 Fig. 10. The same specimen delineated in a different inclination.
 Fig. 11. The largest form raised by the writer. Shell ca. $403 \times 354 \mu$, h: heart.

Pl. X. *Mysella japonica*

- Fig. 1. Young shelled larva just discharged in the water. Shell ca. $124 \times 95 \times 72 \mu$.
 Fig. 2. More advanced stage.
 Fig. 3. Old D-shaped larva. Growth-line visible. Shell ca. $160 \times 133 \mu$.
 Fig. 4. Early umbo-stage. Shell ca. $193 \times 167 \mu$.
 Fig. 5. The same stage seen from the right.
 Fig. 6. More advanced umbo-stage. Shell ca. $209 \times 190 \mu$.
 Fig. 7. The same specimen seen from the right.
 Fig. 8. More advanced stage. Shell ca. $306 \times 280 \mu$.
 Fig. 9. The same stage seen from the right.

Pl. XI. *Paphia philippinarum*.

- Fig. 1. Old D-shaped larva, ca. $176 \times 157 \mu$.
 Fig. 2. Umbo-stage. Shell ca. $209 \times 196 \mu$.
 Fig. 3. Full-grown veliger with degenerated velum and functional foot, shell ca. $227 \times 221 \mu$.
 Fig. 4. Young spat, shell ca. $644 \times 564 \mu$. b.g: byssus gland; h: heart.
 Fig. 5. Ovarian egg of spawning specimen; germinal vesicle has broken down and the first spindle has been formed, ca. $\times 1350$.
 Fig. 6. Beginning of telophase of maturation immediately after insemination, ca. $\times 1350$.

Pl. XII. *Erycina* sp.

- Fig. 1. Young embryo which shows signs of shell-formation.
 Fig. 2. Same stage seen ventrally.
 Fig. 3. Shell is large enough to enclose nearly the whole body. The larva is incapable of free swimming. Shell ca. $180 \times 136 \mu$.
 Fig. 4. Young veliger discharged from mother shell. Shell ca. $220 \times 170 \times 110 \mu$.
 Fig. 5. Growth-line visible. Shell ca. $246 \times 196 \times 113 \mu$.
 Fig. 6. Old D-shaped larva. Shell ca. $273 \times 219 \times 118 \mu$.
 Fig. 7. Early Umbo-stage. Shell ca. $327 \times 280 \mu$.
 Fig. 8. Post-veliger with degenerated velum, enlarged foot and gill-anlage. Shell ca. $351 \times 298 \mu$.

Plate VIII.

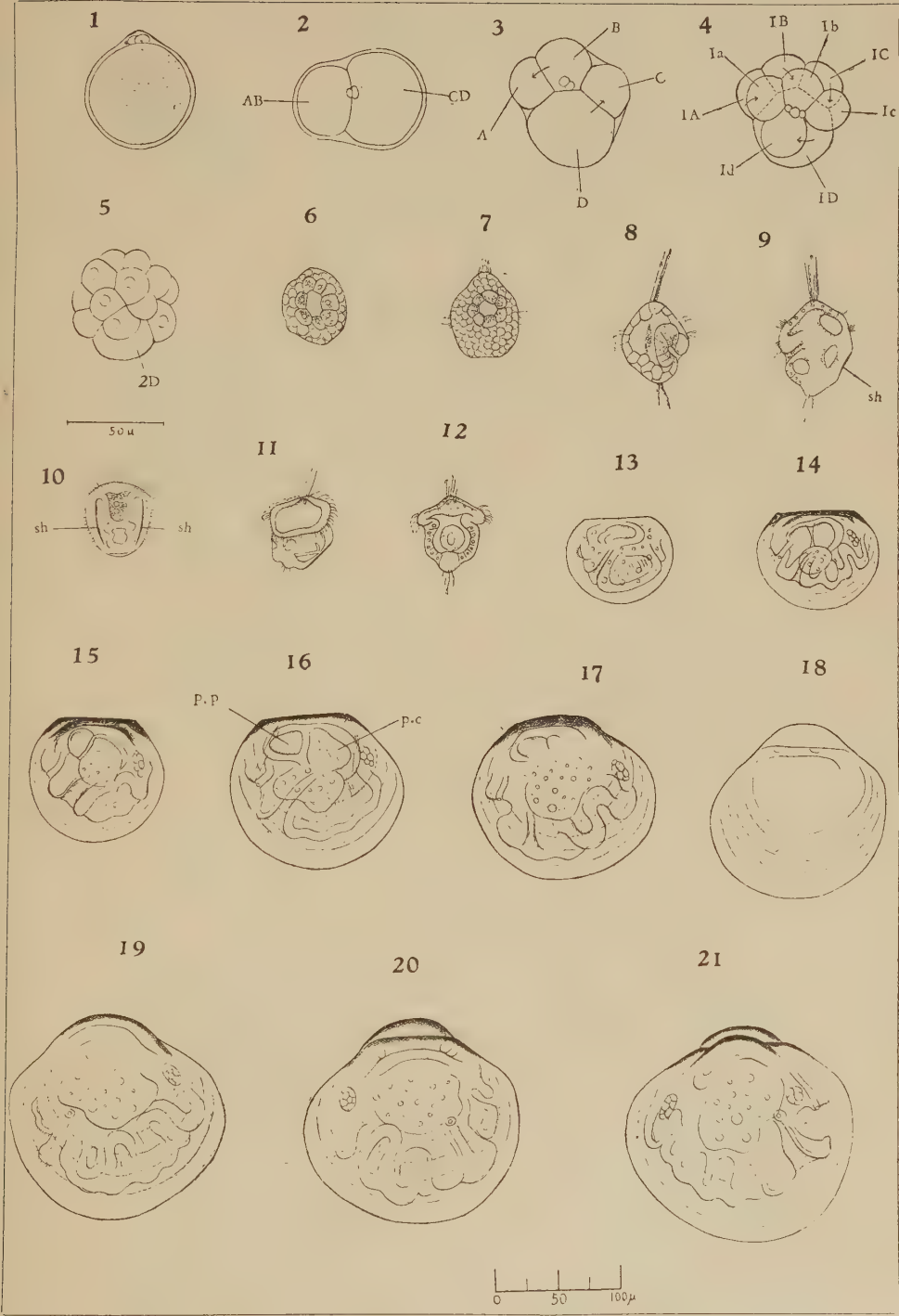


Plate IX.

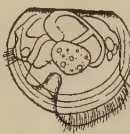
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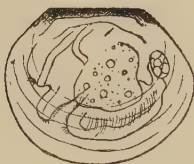
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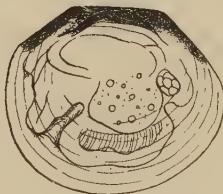
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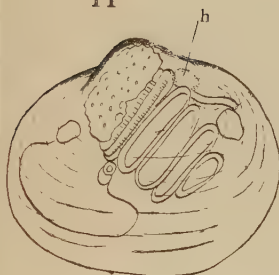
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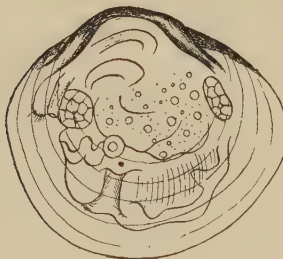
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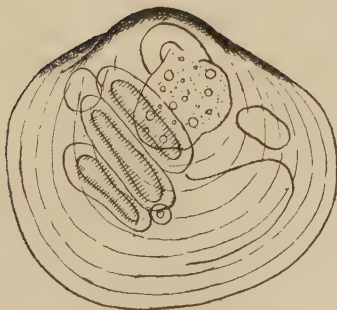
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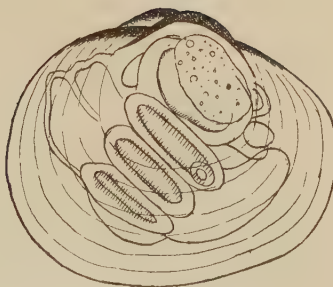
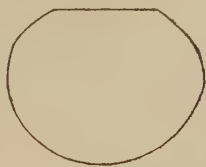


Plate X.

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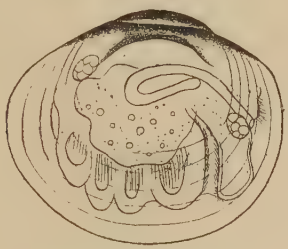
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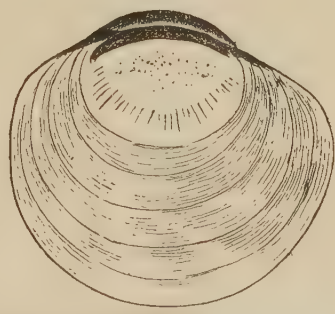


Plate XI.

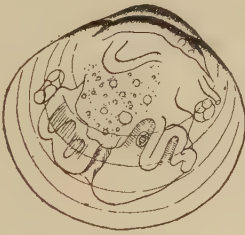
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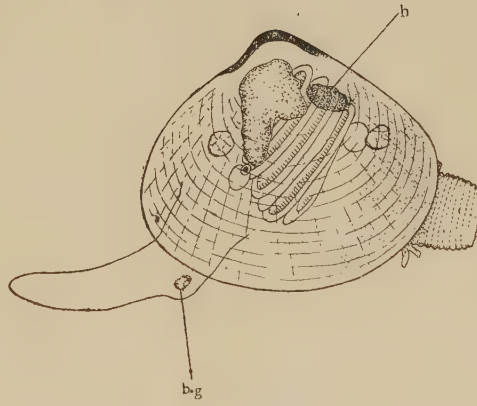
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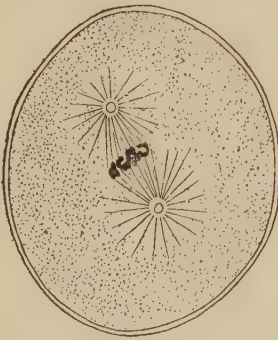
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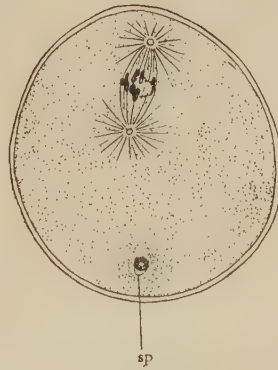
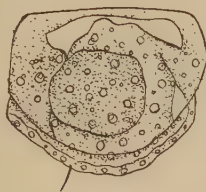


Plate XII.

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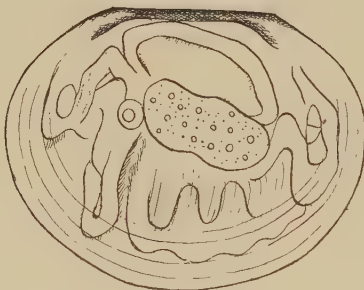
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8



A Description of a New Alpheoid Shrimp from Japan.*

Ituo KUBO.

(Received Nov. 12, 1935)

In the summer of 1935, the present author secured 3 alpheoid shrimps through the courtesy of Mr. H. Ogawa at Mitaziri, Yamaguti Prefecture. Upon careful examination they proved to represent a new species belonging to the genus *Athanas* which has not yet been recorded from Japan. The following description is based on an ovigerous female specimen, 10 mm in total length.

The author wishes to express his gratitude to Professor Arata Terao for his kind supervision and to Mr. H. Ogawa for the collection of the specimens.

Athanas japonicus, sp. nov.

New Japanese name: Murasaki-ebi.

Rostrum horizontal, toothless, laterally compressed, about $1/2.6$ times as long as the carapace, extending to or a little beyond the distal end of the second segment of the antennular peduncle (Pl. XIII, Fig. A). Dorsal carina of the rostrum extends backwards to the anterior half of the carapace.

Carapace smooth, provided with well developed extra-corneal spine but without supra-corneal. Pterygostomian angle rounded, without tooth.

Antennular peduncle consists of three segments; the basal a little longer than the second and bears a long acute spine reaching somewhat beyond the distal margin of the same segment; the third segment is the shortest. Inner antennular ramus much longer than the outer. Outer one proximally composed of 5 joints, but distally divided into stout and slender branches; the stout branch consist of 5 joints whereas the slender one is provided with a large number of joints (Pl. XIII, Fig. F).

Outer margin of the scaphocerite ends in an acute spine which is

* Contributions from the Zoological Laboratory, Imperial Fisheries Institute, No. 47.

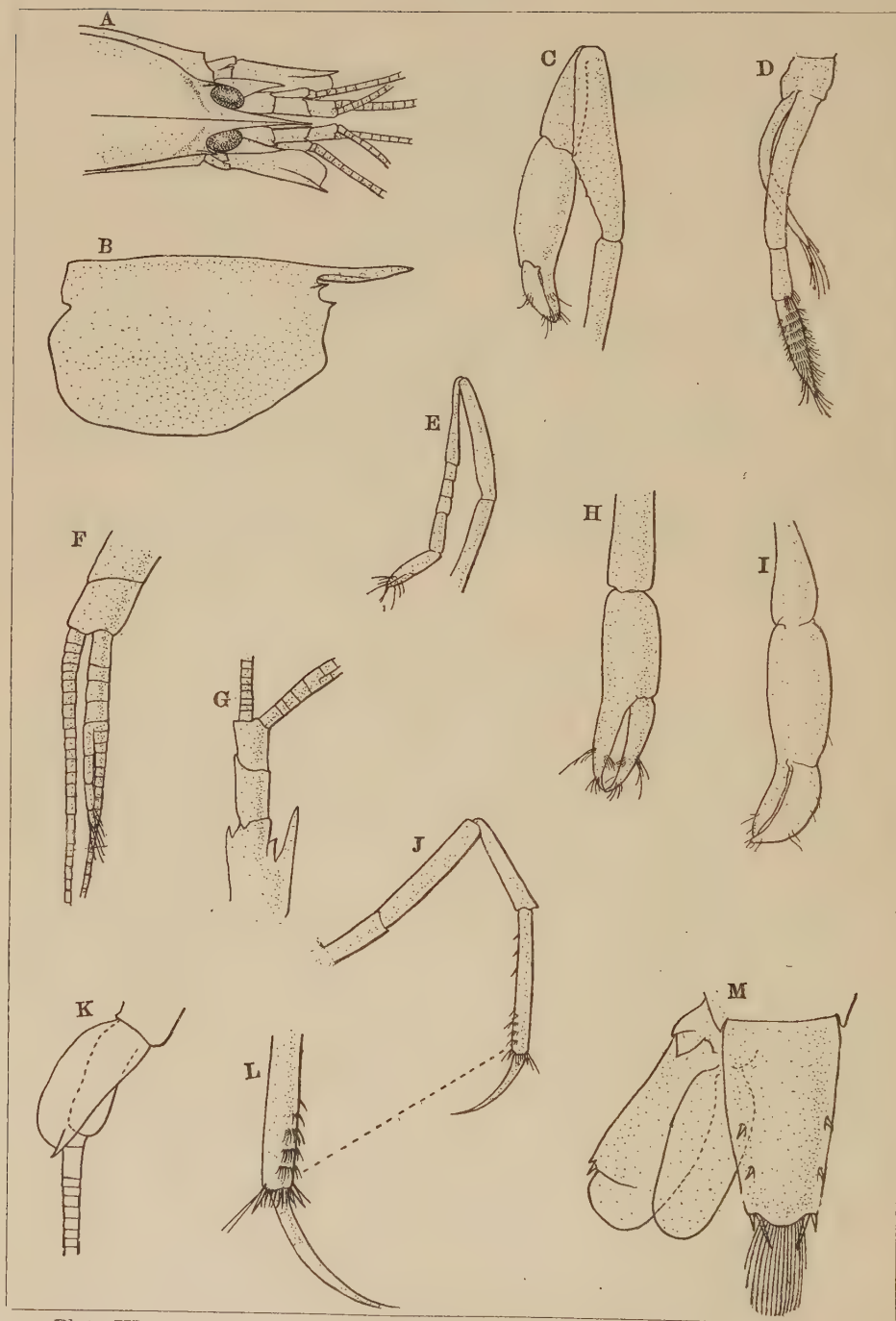


Plate XIII

Explanation of Plate XIII.

Fig. A. Anterior region of *Athanas japonicus* sp. nov. in lateral view ($\times 10$). Fig. B. Carapace and rostrum ($\times 10$). Fig. C. First thoracic leg, ♂ ($\times 25$). Fig. D. Third maxilliped ($\times 25$). Fig. E. Second thoracic leg ($\times 25$). Fig. F. Antennule ($\times 35$). Fig. G. Antennule in lateral view ($\times 25$). Fig. H. First thoracic leg (left), ♀ ($\times 50$). Fig. I. First thoracic leg (right), ♀ ($\times 35$). Fig. J. Fifth thoracic leg ($\times 25$). Fig. K. Antenna ($\times 25$). Fig. L. Dactylus of fifth thoracic leg ($\times 50$). Fig. M. Tail-fan ($\times 35$).

well beyond the margin of the leaf, and the broad apex of the lamella almost reaches to the same level of the distal tip of the antennular peduncle (Pl. XIII, Figs. A & K). Carpocerite does not reach to the end of the scaphocerite, but it ends at the same level as the distal tip of the second segment of the stylocerite.

Third maxilliped composed of five segments, with an exopodite, reaching about to the apex of the rostrum (Pl. XIII, Fig. D). The distal segment twice as long as the penultimate.

First pair of pereiopods robust as compared with the other legs, asymmetrical in size, usually larger in the right side than the left in both sexes, in male they are stouter than in female and slightly outreach the antennal scale.

In right hand, chela $1\frac{2}{3}$ times as long as carpus (Pl. XIII, Fig. C), but shorter than merus, movable finger heavier than the fixed one (Pl. XIII, Fig. I); in the left hand, both fingers are equal in size (Pl. XIII, Fig. H).

Second pair very slender, the wrist consists of five joints, of which the proximal is the longest; chela small, palm and dactylus almost sub-equal (Pl. XIII, Fig. E).

The remaining pairs slender and simple, propodite provided with feeble setae on its posterior margin and armed with lateral rows of setae in distal portion of it (Pl. XIII, Figs. J & L). Dactylus simple, 0.6 times as long as propodite (Pl. XIII, Fig. L).

Abdominal pleura rounded, except those of the fifth and sixth, which are acutely pointed behind as in other species of the genus *Athanas*.

Telson wedge-shaped, and a little less than three times as long as

the breadth between the posterior angles (Pl. XIII, Fig. M). Distal convex margin is furnished with inner longer and outer shorter pairs of strong spines near its right and left angles; it is fringed with long feathered setae on entire margin.

Two pairs of spinules situated near the lateral margin of telson, the proximal pair almost on the middle of the margin. Uropods slightly outreach the terminal margin of the telson.

Besides the type two adult males measuring about 6.5 mm, 6.0 mm respectively in length from the orbital margin to the distal end of the sixth abdominal somite were obtained.

Colour in life deep blue, hence the new Japanese name.

Athanas japonicus is referable to *dimorphus*-group of the genus and very closely allied to *Athanas minikoensis* Coutière. But the present species is readily distinguished from the latter by the characters that the tip of the rostrum much outreaches the distal end of the spine of the stylocerite, and that the chela of the first pair of leg is shorter than the merus. From *A. polymorphus* Kemp it differs in the absence of the spine near the anterior lateral angle of the carapace.

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Two New Littoral Macrurous Crustaceans from Japan.*

Ituo KUBO

(Received Nov. 30, 1935)

In this paper are given the descriptions of two new species, viz., *Periclimenes* (*Ancylocaris*) *akiensis*, and *Betaeus yokoyai*. The specimens of the former were sent to the present author for identification in the spring of 1935 by Mr. T. Nakagawa who obtained them in Inland Sea of Japan, and those of the latter were collected at Kominato, Prov. Bôsyû by Mr. S. Nakamura in the same season.

It is my pleasant duty to return herewith my hearty thanks to Professor Arata Terao for his kind supervision during the course of this study, and to Dr. Y. Yokoya for a loan of the valuable literatures. No less gratitude is due to Mr. S. Nakamura and to Mr. T. Nakagawa for the collection of the material.

Periclimenes (*Ancylocaris*) *akiensis*, sp. nov.

New Japanese name: Aki-ebi.

Carapace provided with an antennal, and a hepatic spine; supra-orbital one absent. Pterigostomian angle rounded without spine.

Rostrum (Pl. XIV, fig. A) almost straight, laterally compressed, moderately long and deep, 0.8~1.0 mm. in the deepest region and 1.3 times as long as the length of carapace; distal tip reaches somewhat beyond the end of antennal scale; dorsal border armed with 8~9 teeth, hindmost two of which are situated on slight carina which extends to the middle of carapace; ventral border with 3~4 teeth; tip of rostrum slightly extends beyond both the dorsal and ventral teeth.

Eyes (Pl. XIV, fig. B) rather slender, three times as long as wide. Cornea hemispherical, traversed obliquely by two parallel wavy dark blue bands. Ocular spot large, touching the cornea.

Basal segment of antennular peduncle with lateral process reaching to its middle, and with terminal spine well developed.

* Contributions from the Zoological Laboratory, Imperial Fisheries Institute, No. 48.

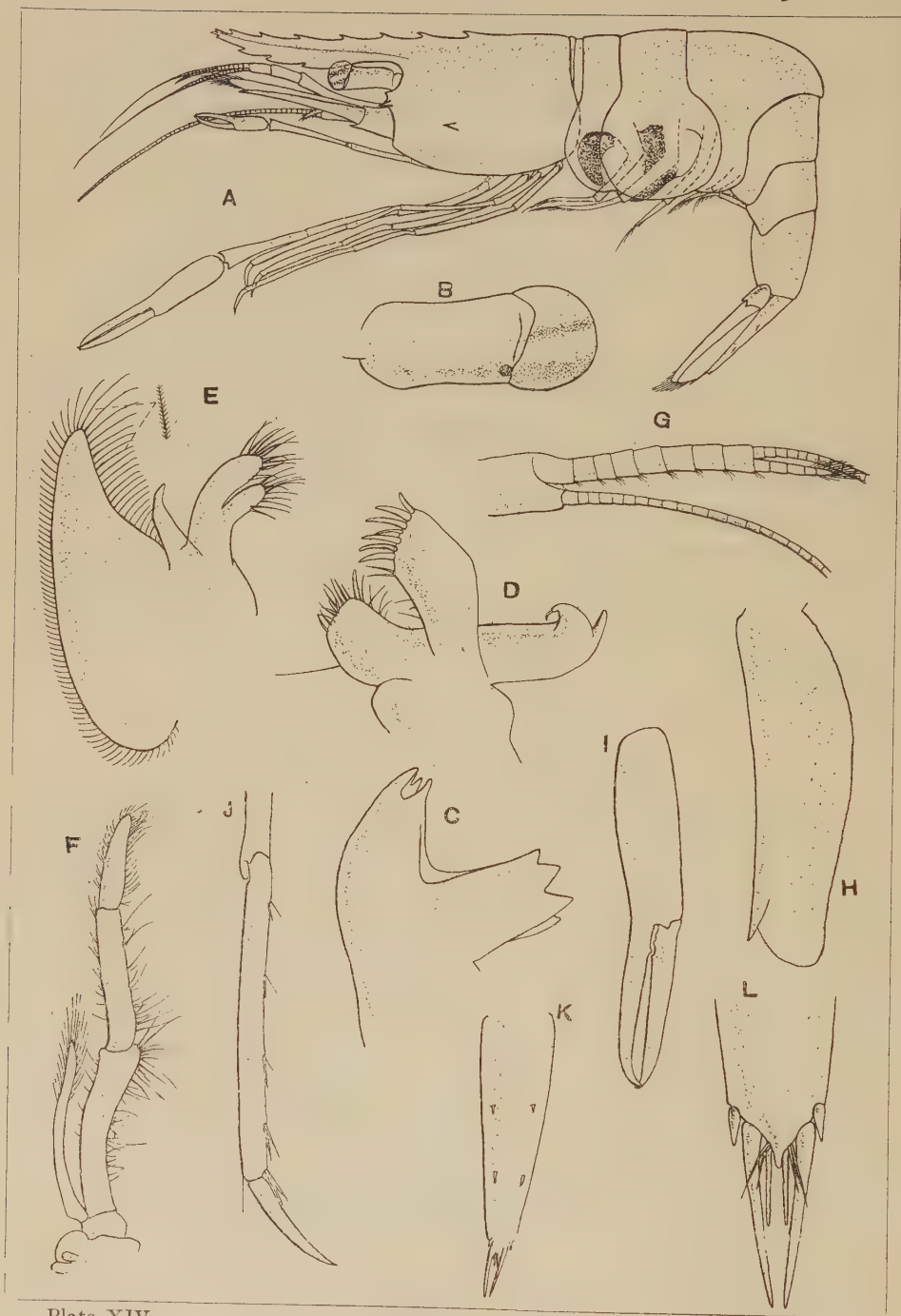


Plate XIV

Explanation of Plate.

Plate XIV.

- A. *Periclimenes (Ancylocaris) akiensis*, sp. nov. ♂, bearing a Bopirid isopoda in the abdomen. ($\times 6$). B. Eye in lateral view ($\times 25$). C. Mandible ($\times 50$). D. Maxillule ($\times 50$). E. Maxilla ($\times 35$). F. Third maxilliped ($\times 15$). G. Antennule with flagella ($\times 25$). H. Antennal scale ($\times 15$). I. Chela of second pereopod ($\times 15$). J. Last two segments of third pereopod ($\times 25$). K. Telson ($\times 15$). L. Tip of telson ($\times 50$).

Shorter ramus of outer antennular flagellum (Pl. XIV, fig. G), with proximal portion comprising 7 or more joints, and distal portion bifid, shorter branch consisting of about five joints.

Antennal scale (Pl. XIV, fig. H) 3 times as long as wide, not tapering. Outer margin slightly concave and terminated in an acute spine which does not stretch beyond the end of lamella.

Mandible (Pl. XIV, fig. C) simple, without palp. Maxillule (Pl. XIV, fig. D) cross-shaped, distal margin of outer lacinia provided with a series of strong setae, endopodite carrying a thumb-like apical process.

First maxilliped bears epipodite; exopodite long, whip-shaped and armed with six or more pairs of long feathered setae in distal region.

Third maxilliped (Pl. XIV, fig. F) consists of five articulations. Penultimate segment 1.32 times in female and 1.46 times in male as long as ultimate one.

First pereopod reaches slightly beyond the tip of rostrum; chela, carpus and merus sub-equal in length. Fingers unarmed, 1.21 times as long as palm.

Second pereopods more robust and much longer than the first one, reaching beyond antennal scale by the entire chela. Fingers (Pl. XIV, fig. I) have inturned tips and straight cutting edges, with one distinct tooth and several small incipient teeth in the proximal one-fifth. Finger and palm sub-equal; carpus a little longer than merus, and both the two have no spine on the distal border.

Third, fourth and fifth legs very similar in many respects, but the fifth a little longer than the preceding two legs. Dactylus moderately curved, horn-shaped and simple; propodus much longer than carpus, armed with a series of slender spines frequently arranged in

pairs on its posterior border (Pl. XIV, fig. J).

Sixth abdominal somite 1.8 times the length of the fifth one in male, but 2.1 times in female.

Telson tapering, rounded above, provided with two pairs of dorsal spines which are situated so as to divide equally its length into three, with three pairs of spinules on the terminal border, the middle pair the longest.

Type locality: Simokamogari-mura, Province Aki. Specimens were captured by trawl net in weedy shallow water.

Measurements: Total length from terminal tip of rostrum to distal end of telson 15 mm in female, 23.5 mm, 22.5 mm and 19.0 mm in males.

Notes: The female was found carrying eggs which are 0.5 mm in diameter. Each of these three male specimens was found bearing a couple of Bopyrid isopods under their abdomen.

Difference: *Periclimenes* (*Ancyrocaris*) *akiensis* is closely related to *P.* (*Ancyrocaris*) *americanus* (Kingsley), but differs from it in the following points:—(1) Rostrum not shallow. (2) First pereopods reaching beyond antennal scale by the half length of chela. (3) Second pereopods reach beyond the antennal scale just by the length of chela. (4) Finger and palm of second pereopods are sub-equal in length. (5) Third pereopods reach to or slightly beyond the tip of antennal scale.

Betaeus yokoyai, sp. nov.*

New Japanese name: Yokoya-ebi.

Body somewhat laterally compressed, dorsally rounded. Carapace smooth, carrying no tooth. Upper frontal margin not projecting into rostrum, but with a notch which is followed by a shallow groove. Orbital hoods slightly projecting and forming both sides of the notch.

Eyes small, entirely covered by carapace, measuring 1.0~1.3 mm in diameter.

First antennal peduncle composed of three sub-equal articulations; the basal segment has proximally a large spine reaching to a little beyond the middle of second joint.

* The specific name is given in honour of Dr. Y. Yokoya who first described a species of this genus from Japan.

Second antennal peduncle extends slightly beyond the terminal tip of first antennal peduncle. Flagella thick and tapering, almost as long as first thoracic leg.

Table (1)

Speci. No.	B.	B'.	L.	S.	L./B.	S/B'	F.	F'.	P.	P'.	P/F	P'/F'
1.	42.5	36.5	38.0	25.0	0.89	0.68	8.0	6.8	13.5	6.4	1.68	0.94
2.	37.0	30.5	26.5	19.0	0.71	0.62	6.1	4.7	9.0	5.3	1.47	1.12
3.	45.4	38.5	37.5	28.0	0.82	0.72	7.9	7.0	13.3	7.1	1.68	1.01
4.	45.2	39.0	30.0	18.9	0.66	0.58	7.0	4.5	8.0	4.3	1.15	0.95
5.	45.0	39.0	35.0	26.0	0.77	0.66	7.5	6.2	12.0	6.9	1.60	1.11
6.	42.0	36.5	34.5	25.5	0.82	0.69	7.5	6.0	12.5	7.0	1.66	1.16
7.	32.0	27.5	22.5	17.0	0.70	0.61	5.0	4.0	8.0	4.5	1.60	1.12

B. Total body length including telson. B'. Body length without telson. L. Length of larger leg in the first pair of pereopods. S. L. of smaller leg of the same pair. F. L. of movable finger of the larger leg. F'. L. of movable finger of the smaller leg. P. L. of the palm of the larger leg. P'. L. of palm of the smaller leg.

Mandible (Pl. XV, fig. C) with two-jointed palp. Maxillule (Pl. XV, fig. D) representing φ shape, with its inner lacinia cylindrical and distally tapering. Endopodite terminated into one strong seta and with an apical lobe bearing many long bristles on its distal border. Third maxilliped consists of five segments, its ischio-meropodite and basipodite are granulated on their outer margin.

First pereopods very robust, granulated except two basal segments, asymmetrical; right one usually massive and with chela of inverted type. The larger chela not longer than total length of body including telson as shown in table 1. Its movable finger somewhat exceeds fixed one in length. A circular space formed between these two fingers when closed since each has a semicircular notch near the middle of each incisor edge. Ratio of the movable finger to palm is 1:1.15~1.68. Palm cylindrical, more or less laterally compressed. The other chela longer than the half of body length without telson (Table 1); cutting edges of both fingers straight and remaining no gap between them.

Second thoracic legs slender, symmetrical and also chelate in

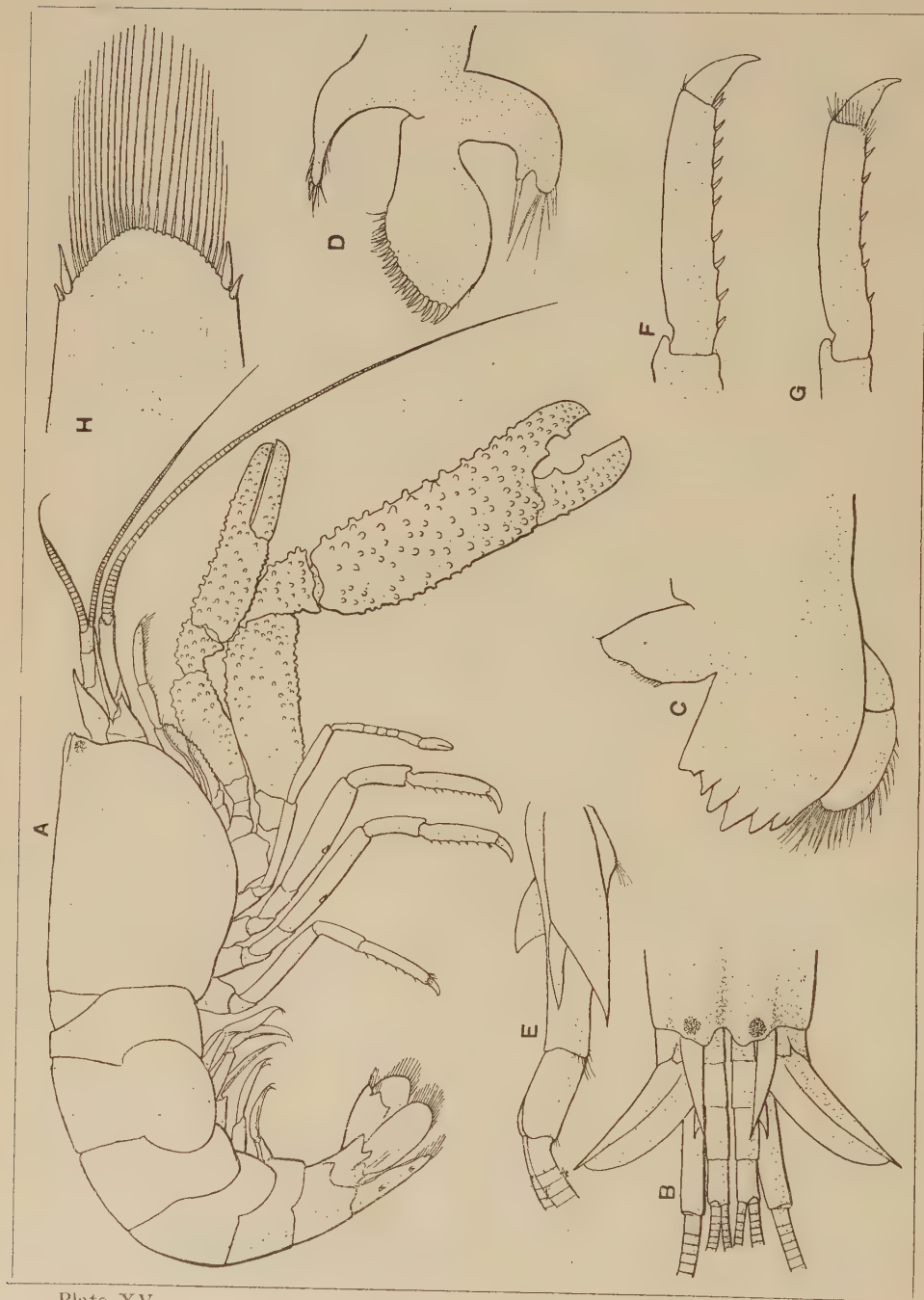


Plate XV.

Explanation of Plate.

Plate XV.

A. *Betaeus Yokoyai*, sp. nov. ($\times 2\frac{1}{2}$). B. Frontal region of the same animal, dorsal aspect. ($\times 3\frac{1}{2}$). C. Mandible ($\times 7\frac{1}{2}$). D. Maxillule ($\times 10\frac{1}{2}$). E. Antennular peduncle, inner view ($\times 7\frac{1}{2}$). F. Last two segment of third peraeopod ($\times 7\frac{1}{2}$). G. Last two segment fifth peraeopod ($7\frac{1}{2}$). H. Tip of Telson ($\times 15$).

normal type, carpus divided into five segments, the proximal being the the longest.

Third (Pl. XV, fig. H) and fourth legs alike. Their merus carries a spine on outer border near its middle. Posterior margin of propodus provided with 7~9 spines and the distal one usually paired. Dactylus simple and short, about one third as long as propodus.

Fifth legs (Pl. XV, fig. G) entirely similar to the preceding one, but merus without spine and the terminal region of propodus is fringed with setae.

Telson (Pl. XV, H) wedge-shaped, with dorsally planted two pairs of spines. Both angles of posterior end occupied by two pairs of spines, its inner one longer and stronger than the other one. Intermediate margin between these spines gently rounded and carrying about 25~27 long plumose bristles.

Branchial system is as follows:—

	<i>h</i>	<i>i</i>	<i>k</i>	<i>l</i>	<i>m</i>	<i>n</i>	<i>o</i>
Pleurob.	—	1	1	1	1	1	—
Arthrobr.	—	1	—	—	—	—	—
Podob.	—	—	—	—	—	—	—
Mastigob.	1	r	r	r	r	r	—

Colour and habitat: This animal is coloured brownish green or brownish blue in life, and occurs commonly under stones near low tide-mark at Kominato and is abundantly found in spring.

Difference: *Betaeus yokoyai* closely resembles *B. granulimanus* Yokoya, but it may be separated from it by the following points:—

- (1) Three segments forming first antennal peduncle sub-equal in length.
- (2) Length of larger leg in the first pair of pereopod not longer than total body length; its length 0.66~0.89 times as long as total body

length. (3) Length of the another one in the same pair is shorter than body length without telson. (4) In the same leg, the fingers do not arch not to leave a wide gap between them when closed.

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On Japanese Penaeid Crustaceans belonging to the Genus
Parapenaeopsis, with a Description of one New Species.*

Ituo KUBO

(Received Dec. 18, 1935)

In Inland Sea of Japan 24 specimens of a new species of *Parapenaeopsis*, namely, *P. brevirostris*, and 46 individuals of *P. tenella* (Bate) were obtained in August, 1935. A description of the former and statistical observations on the latter coupled with the key to the Japanese species of this genus are given in this paper.

The author is under obligation to Professor Arata Terao for his kind supervision under which the present study was carried out.

Parapenaeopsis brevirostris, sp. nov.

New Japanese name: Maimai-ebi.

Carapace smooth, bearing an epigastric, supra-orbital, antennal and hepatic spines. Sulcate crest on carapace is not present. Post-rostral carina continues nearly to posterior end of carapace.

Rostrum straight, nearly reaching to or a little beyond the distal end of eyes, laterally compressed, ending in an acute point, upper border armed with spines, mostly 8 but varying from 6 to 8 in number; posterior spine (not including epigastric spine) situated behind orbital margin.

Eye small, about 15/100 the length of carapace (Table 1), stalk slender.

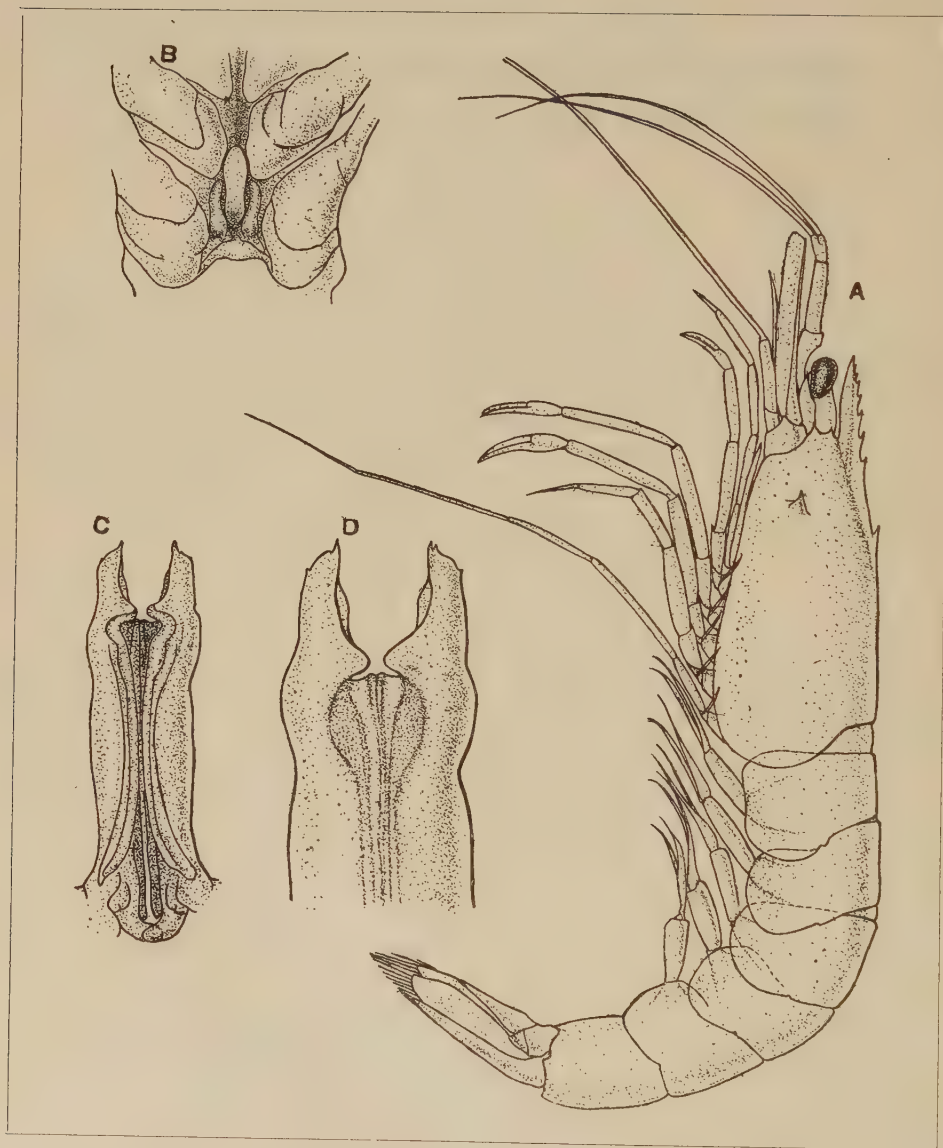
Antennules with second and third segments of its peduncle reaching beyond rostrum and eyes; flagella a little more than twice as long as carapace.

Third maxillipeds reach to distal end of antennal scale when stretched out.

First pereopod shortest of all thoracic legs, about 9/10 the length of carapace, reaching to or slightly beyond distal end of rostrum.

Second and third pereopods nearly equal in length, about 1.3 times

* Contributions from the Zoological Laboratory, Imperial Fisheries Institute, No. 49.



Explanation of Plate XVI

A. *Parapenaeopsis brevirostris*, sp. nov. ($\times 3$). B. Thelycum ($\times 7\frac{1}{2}$). C. Petasma, Ventral view. ($\times 20$). D. Distal region of petasma ($\times 35$).

Table I. Measurement of 22 ♀ and 2 ♂ of *P. brevirostris*.

	Range		Mode		Mean		S. D.		C. V.	
	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂
I	2.56~3.00	3.28~3.38	2.75	—	2.83±0.015	3.14	0.109±0.011	—	3.85±0.391	—
II										
V	0.79~0.95	0.87~0.99	0.89	—	0.88±0.059	0.86	0.36 ±0.041	—	4.10±0.473	—
II										
VI	1.09~1.36	—	1.32	—	1.28±0.022	—	0.12 ±0.015	—	9.32±1.232	—
II										
VII	1.17~1.45	1.38~1.48	1.98	—	1.32±0.015	1.43	0.09 ±0.010	—	6.59±0.811	—
II										
IIIX	0.98~1.24	—	1.08	—	1.11±0.014	—	0.08 ±0.010	—	7.39±0.910	—
II										
IX	1.87~2.27	—	1.88	—	1.92±0.020	—	0.06 ±0.014	—	3.18±0.762	—
II										
X	0.50~0.63	0.52~0.56	0.54	—	0.56±0.051	0.55	0.04 ±0.003	—	6.47±0.660	—
II										
E	0.10~0.17	0.17~0.18	0.15	—	0.15±0.002	0.18	0.02 ±0.001	—	1.03±0.111	—
II										
Tel.	1.05~1.29	1.11~1.37	1.23	—	1.19±0.007	1.24	0.05 ±0.005	—	4.28±0.444	—
S.A.S.										
S.N.R.	6~8		8		1+7.45±0.005		0.04±0.004		5.10±0.518	

I=Body length without rostrum and telson. II=length of carapace without rostrum. V=L. of first thoracic leg. VI=L. of second thoracic leg. VII=L. of third thoracic leg. IIX=L. of fourth thoracic leg. IX=L. of fifth thoracic leg. X=Depth in thickest portion of carapace. E=Horizontal diameter of eye. Tel.=L. of telson. S. A. S.=L. of sixth abdominal somite. S. N. R.=Number of spine on rostrum.

as long as carapace. Basipodite and ischiopodite of second legs with a spine at each inner distal end.

Fourth legs somewhat shorter than preceding two pairs of legs but longer than the first.

Fifth legs the longest and very slender, about two times as long as carapace.

Pleon slightly carinated from the fourth somite backwards. Sixth abdominal somite shorter than telson which is nearly 1.2 times as long as sixth abdominal segment.

Telson tapering, canaliculated on dorsal surface. Lateral margin fringed with long setae of plumose structure.

Thelycum (Pl. XVI, fig. B) consists of two parts: one long leaf-shaped median plate and a pair of slender side plates, proximal end of median

plate nearly reaching to the middle of the base of fourth thoracic legs.

Petasma (Pl. XVI, figs. C, d) stout, ending in two massive cornua directed straightly forwards.

Branchial arrangement is as follows:—

	<i>h</i>	<i>i</i>	<i>k</i>	<i>l</i>	<i>m</i>	<i>n</i>	<i>o</i>
Pleurob	2?	r	r	r	r	1	—
Arthrob.	1	2	2	2	2	—	—
Podob.	—	—	—	—	—	—	—
Mastigob.	1	—	1	1	1	—	—

Colour and habitat. Colour uniformly pinkish in life. Specimens were obtained from Inland Sea at depths 10~20 fathoms. Apparently they are all adults since the female specimens were found containning numerous ovarian ova.

Parapeneopsis brevirostris belongs to the group which has mastigobranchiae on second maxillipeds and on the first two pairs of thoracic legs. It is easily distinguished from other species belonging to the same group, namely, *P. sculptilis*^(2, 7), *P. hardwickii*^(7, 11, 16), *P. cultrirostris*⁽³⁾, *P. cornata*^(12, 15), *P. uncta*⁽²⁾, *P. nana*⁽²⁾, *P. gracillima*^(4, 5) and *P. balli*⁽⁷⁾ by having considerably shorter rostrum.

Parapeneopsis tenella (Bate)

Penaeus tenellus, 1888, P. 270. Kishinouye, 1900. P. 22, Pl. 6, fig. 5, and Pl. 7, fig. 8a, b.

Penaeus (*Parapeneopsis*) *tenellus*, de Man, 1907, PP. 435~436.

Rostrum more or less convex, number of rostral spines varying 5~9, its mode 8. (Table 1).

Eye moderately large, about $\frac{1}{5}$ the length of carapace without rostrum.

Depth in the thickest region of cephalothorax about half the length of carapace, being 0.56 times in female and 0.54 times in male.

Body excepting rostrum and telson is 2.97 times in female, 3.25 times in male as long as carapace; male is somewhat slenderer than female.

First thoracic legs shortest, 0.62 times in female, 0.60 times in male as long as carapace. Fifth thoracic legs longest of all legs, 1.54 times in female, 1.21 times in male as long as carapace.

Telson about $\frac{9}{10}$ the length of sixth abdominal somite.

P. tenella,
Table II.

	Range		Mode		Mean		S. D.		C. V.	
	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂
I II	2.53~3.15	2.80~3.47	2.97	3.25	2.97±0.009	3.25 ±0.019	2.97±0.08	3.26±0.09	2.83±0.22	2.89±0.41
V II	0.52~0.68	0.50~0.66	0.62	0.65	0.62±0.051	0.600±0.010	0.63±0.04	0.61±0.05	7.20±0.56	8.49±1.42
VI II	0.71~0.93	1.71~0.94	0.81	0.81	0.80±0.006	0.81 ±0.012	0.81±0.05	0.82±0.05	6.56±0.52	6.60±1.04
VII II	1.03~1.23	1.00~1.24	1.12	1.22	1.16±0.005	1.16 ±0.015	1.16±0.04	1.16±0.06	4.06±0.32	5.51±0.92
IIIX II	1.09~1.29	1.10~1.41	1.21	1.15	1.18±0.007	1.18 ±0.025	1.18±0.06	1.18±0.10	5.75±0.49	8.91±1.49
IX II	1.23~1.81	1.45~1.77	1.55	1.52	1.54±0.012	1.22 ±0.011	1.54±0.10	1.22±0.04	6.81±0.57	3.53±0.68
X II	0.51~0.61	0.50~0.60	0.56	0.55	0.56±0.002	0.55 ±0.005	0.57±0.02	0.55±0.02	4.42±0.35	4.92±0.70
E II	0.19~0.26	0.26~0.34	0.21	0.31	0.22±0.021	0.28 ±0.005	0.22±0.18	0.28±0.02	8.48±0.68	9.35±1.34
Tel. S.A.S.	0.88~0.98	0.85~0.95	0.97	0.92	0.93±0.004	0.91 ±0.006	0.93±0.04	0.91±0.03	4.51±0.36	3.30±0.47
S.N.R.	5~9		8		7.57±0.07		0.04±0.004		9.51±0.68	

Abbreviations are just same as in table I.

Key to the Japanese species of genus *Parapenaeopsis*.

- A. Carapace bearing epigastric spine or isolated spine.
- a. Rostrum extending beyond eye for about anterior half of its length. Anterior end of petasma divided into two horn-like slender processes. Median plate of thelycum broad and oblong. Lateral plate coalesced. Fifth legs not longer.
*P. cornuta*.
- aa. Rostrum not exceeding the distal end of eye. Eye small; petasma ending in two massive cornua. Median plate of thelycum slender and leaf-shaped, lateral plate not coalesced. Fifth legs much longer than preceding legs.
*P. brevirostris*.
- AA. Carapace without epigastric or isolated spine, rostrum somewhat convex. Petasma thin and broad, having a pair of lateral horns. Median plate of thelycum large, logenge shaped.
*P. tenella*.

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A New Homoloid Crab from Japan*

Ituo KUBO

(Received March 15, 1936)

The present new species, *Latreillopsis major*, is based on a male and an ovigerous female obtained off Kominato, Prov. Bôsyû at a depth of about 170 fathoms. The author begs to record his indebtedness to Dr. A. Terao for his valuable help rendered to him during the course of his study. He is much obliged to Mr. S. Nakamura for the collection of the material, and to Dr. Y. Yokoya and Mr. T. Sakai for giving him access to important literatures.

Latreillopsis major, sp. nov.

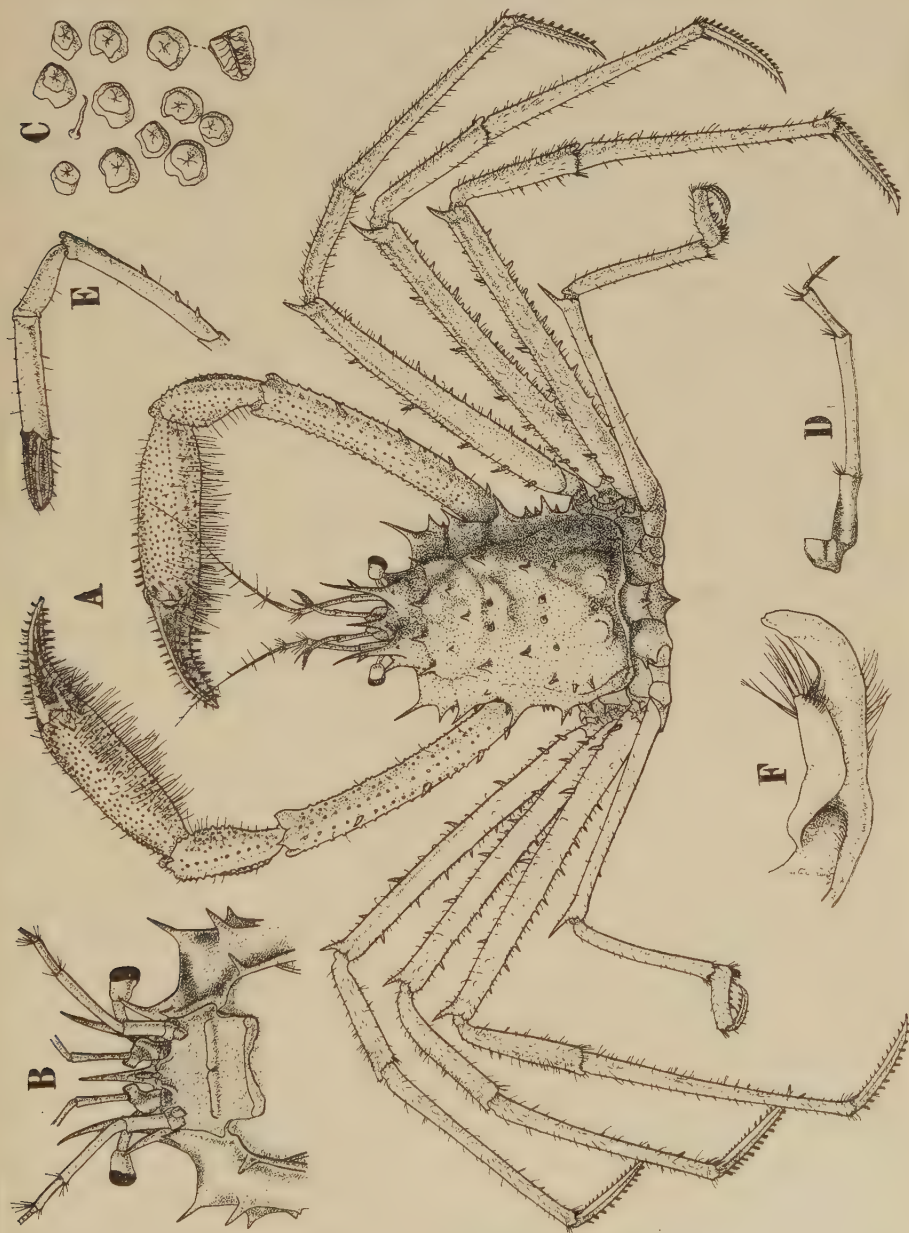
Body entirely covered with thickly set hairs, which consist of long and wart-like short ones (Pl. XVII, Fig. C). Carapace sub-quadrate in outline, upper surface is studded with strong short and long spines, 15~19 spines projecting from the descending side; a single pointed moderately long (Table 1) rostral spine is inconspicuous, slightly ascending near its tip; supra-orbital one well developed and longer than the rostral one, directed slightly outwards near its tip and usually has a small obliquely directed spine at distal one-third; sub-orbital one smaller than the supra-orbital one, directed forwardly and outwardly; antero-lateral one long and stout, directed obliquely forwardly. Linea anomurica and cervical groove distinct; frontal, hepatic, two-spined urogastric, and intestinal regions depressed; protogastric region slightly convex and provided with a transverse series of four strong spines, of which central two spines erect and distal two directed slightly outwards; meso-gastric with a strong spine; cardiac area provided in its elevated apex with two spines which are smaller and blunter than the spines that are found in proto-and meso-gastric regions; both sides of intestinal region elevated in the form of knobs. Orbit broad, shallow and incomplete. Eye pear-shaped, borne at the distal end of the distally

* Contributions from Zoological Laboratory, Imperial Fisheries Institute, No. 50.

narrowed peduncle which is slender and 1.1 times as long as eye. Antennule with 3 segments, basal one enlarged, ultimate one slightly shorter than penultimate one; both flagella a little shorter than the ultimate segment, outer flagellum thicker than inner one. Antennal peduncle (Fig. D) much longer than antennuler, consisting of 3 joints, the penultimate joint being the longest, 2.2 times as long as ultimate one (Table 1), with opening of green gland on the top of short cylindrical tube attached to the base of the basal segment, and a small spine situated a little outwardly. Epistome broad in its middle, divided transversely by a ridge which has a small notch in its medial portion. Buccal cavity provided with a stout and outwardly directed spine near its antero-lateral angle (Pl. XVII, Fig. B).

Mandible with a small tooth in the anterior one-third of the cutting edge of right side one. Mandibular palp with 3-joints, the intermediate joint being the longest. Third maxilliped densely beset with setae on inner margin; dactylus and propodus elongated and cylindrical, the former slightly longer than the latter; carpus short; merus and ishium subequal in length and laterally compressed, the former serrated with spinules along the posterior two-thirds of outer margin, armed with a tubercle near the posterior one-third of inner margin, the latter with a blunt spine near anterior corner and tubercles on inner basal margin.

First pair of pereopod symmetrical and sub-cylindrical in both sexes, length (from the proximal end of merus to the tip of dactylus) 181 mm or 2.9 times as long as carapace in male, 89 mm or 1.7 times as carapace in female (Table 1); each segment covered with small tubercles or granules. In male, chela is massive and hairy especially more thickly set on inner margin, palm about 1.6 times as long as movable finger; fingers tapering and slightly curved inwards in anterior one-third and provided with bundles of setae, leaving no space between them when closed in distal half, incisor margin of movable finger provided with a tooth near its base, but fixed one without tooth; distal border of dorsal surface of merus has a short spine and the posterior border also armed with several serrated spines. In female (Pl. XVII, Fig. E), without tubercles or granules, palm somewhat laterally compressed, 1.5 times as long as movable finger, cutting edge almost straight in both fingers, with no tooth, and leaving no space between the fingers. Merus armed with four teeth on its posterior



Explanation of Plate XVII

- A. *Latreilopsis major*, sp. nov. ♂. $\times 1/2$. B. Ventral view of the anterior region of the same specimen. $\times$ ca $4/5$. C. Hairs of body surface. $\times$ ca 33. D. Basal three segments of antenna. $\times 4/3$. E. First pereopod of female. $2/3$. F. Anterior male abdominal appendage. $\times 8/3$.

border as is the case with male. Following three pairs of pereopod present very similar appearances (Table 1); dactylus as long as carpus, its inner margin furnished with about a dozen of graduated spines (number being not constant in each leg), increasing in length towards the horny nail; outer margin provided with bundles of setae; propodus slender, bearing a spine on inner border at distal one-sixth and with shallow groove on its dorsal surface; merus armed with strong serrated spines on anterior and posterior margins, and with shallow groove on upper surface, distal dorsal border armed with a prominent spine. Fifth pereopod slenderer than the other and the shortest; both dactylus and propodus very short, furnished with several spines on their inner border, assuming cheliform aspect; merus without shallow groove nor serrated spines but a small tooth on distal one-fourth of posterior border and a stout one on distal dorsal margin. Anterior male abdominal appendage (Fig. F) hooked near its tip and the proximal region tubular and hairy. Each of the first four abdominal segments provided with a central spine, and a small one at the end of the sixth. Seventh abdominal somite sub-triangular in shape and excavated with shallow groove along distal half of median line and also longitudinally grooved in middle region near both margins.

Branchial formula:—

	<i>h</i>	<i>i</i>	<i>k</i>	<i>l</i>	<i>m</i>	<i>n</i>	<i>o</i>
Pleurob.	—	—	—	1	1	1	—
Arthrob.	1	2	2	1+r	1+r	—	—
Podob.	1	—	—	—	—	—	—
Mastigob.	1	1	1	r	r	—	—

Color in life blackish brown in body and legs but black in the fingers of chelipeds and cornea.

Latreillopsis major is closely allied to *L. alcocki*⁷⁾ which is known from Algon Bay (South Africa), but it is easily separated from the latter in having 2nd segment of Antenna about 2 times as long as third one (in *L. alcocki*, it is 5 times).

Table 1. (Dimensions in mm)

Spec. No.	A L. of Rost.	B L. of Carap.	C Bread. Carap.	D L. of 1st leg	E L. of 2nd leg	F L. of 3rd leg	G L. of 4th leg	H L. of 5th leg	I L. 2nd Seg. 2nd Anten.	K L. 3rd Seg. 2nd Anten.	I/K				
*1 ♂	10.0	61.5	50.0	181.0 2.94	213.5	3.47	214.5	3.49	222.3	3.61	125.0 2.03	13.0	6.0	2.17	
2 ♂	8.5	43.0	35.3	107.5 2.50	151.5	3.52	143.5	3.34	148.5	3.45	63.0	1.47	5.0	2.00	
3 ♂	8.0	42.0	34.5	103.0 2.45	142.5	3.39	157.5	3.75	—	—	—	9.6	4.4	2.18	
*4 ♀	8.0	51.5	43.0	89.0 1.73	148.0	2.87	166.0	3.22	162.0	3.15	94.0	1.83	—	—	
5 ♀	7.0	42.5	35.0	74.5 1.75	131.0	3.08	—	—	—	—	86.0	2.02	9.0	4.2	2.14

A. Length of rostral spine.
C. Breadth of carapace.
E. Length of 2nd leg.
G. Length of 4th leg.
I. Length of 2nd segment of antenna.
* Type specimens.

B. Length of carapace.
D. Length of 1st leg.
F. Length of 3rd leg.
H. Length of 5th leg.
K. Length of 3rd segment of antenna.

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On the Growth of *Evynnis cardinalis* (LACÉPÈDE)*

Ken-ichi EBINA

(Received March 15, 1936)

Papers on *Evynnis cardinalis* (LACÉPÈDE) have been written by Jordan, Fowler, Kishinouye, Tanaka and Oshima, *et al.* but their measurements do not always agree. The author took a correct measurement of every part from a good number of specimens of *Evynnis cardinalis* and studied the growth and the changes that take place as the fish gets older.

A grateful acknowledgment is here made to Professor Terao for his kind advice given to the author in the course of his study. His best thanks are due to Assistant Professor Matsubara for lending him literatures on this subject.

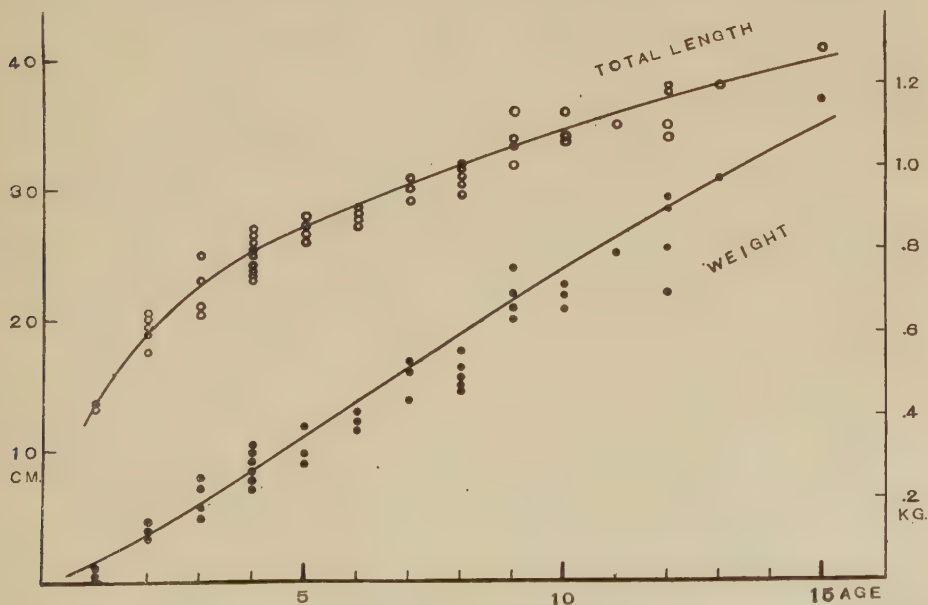


Fig. 1. Total length and weight against the age.

* Contributions from the Zoological Laboratory, Imperial Fisheries Institute, No. 51.

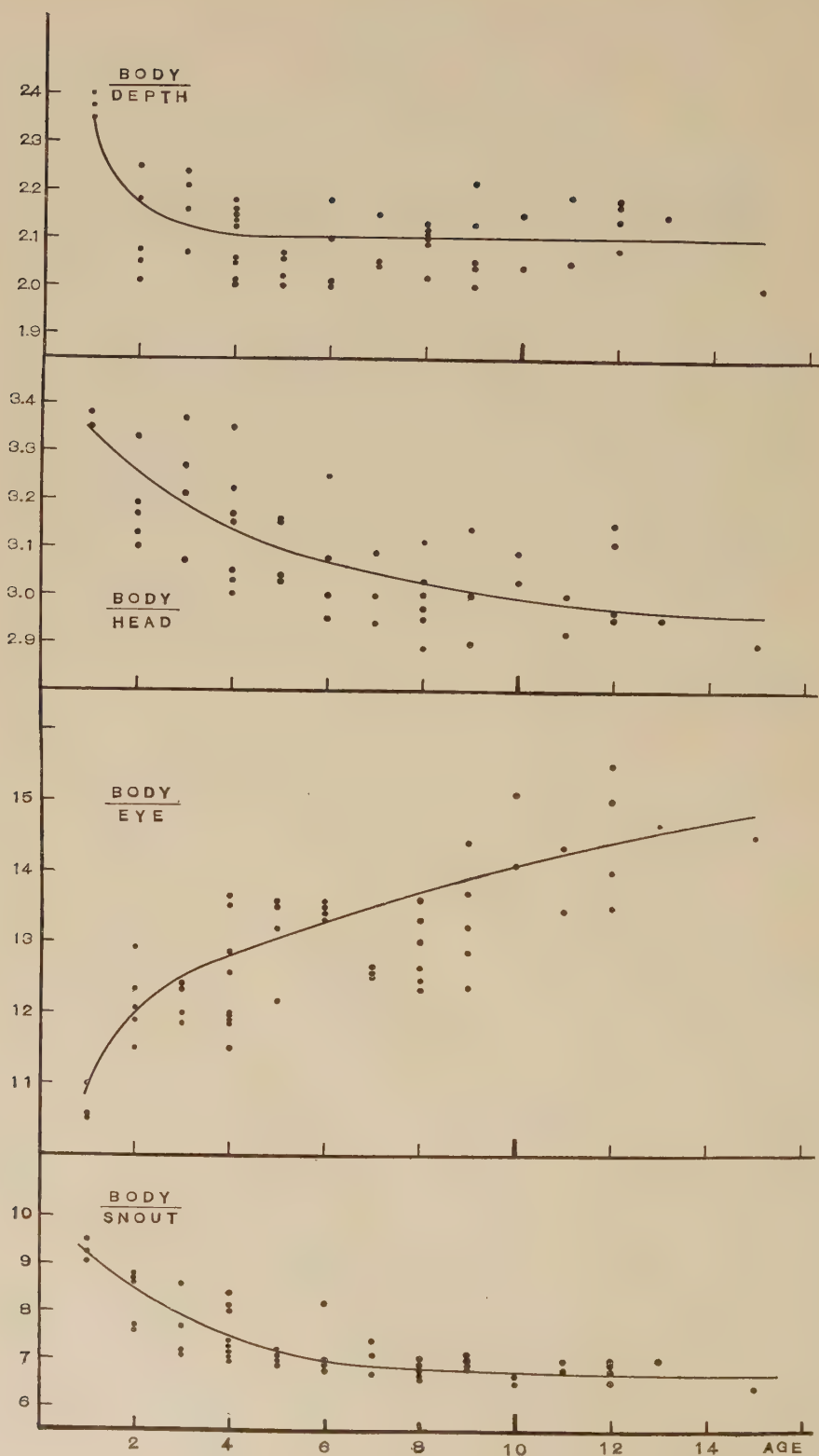


Fig. 2. Ratio of body length to depth, head, eye, snout against the age.

Materials used in the present work are 50 specimens sold at Tokyo fish-market as the ones that have been caught in Izu, Misaki, Bōsyū, Tyōsi and Mito.

Age, total length and weight of body. The age has been determined by the year rings of 5 to 6 scales, which were taken from near the middle of the side of the body. As *Evynnis cardinalis* is a fish that breeds in autumn, the first winter ring is almost indistinguishable, but it can be clearly seen from the second year. It differs from the other Sparoid fish in this respect.

The largest specimen measured by the author was 410 mm. in total length and weighed 1,171 grams. Kishinouye reports that the fish grows as large as 420 mm. As shown in the line of growth indicated in Fig. 1., it grows relatively fast up to 3 to 4 years old, and when it gets over 5 years old its growth slows down somewhat, but seeing that it is not yet asymptotic at 15 years of age, it may be assumed that some live more than 20 years.

The weight of the body indicates a tendency of increase almost in a straight line from the second year. In comparing this with *Pagrosomus major* Temminck & Schlegel, its growth, as a whole, is extremely slow. Ten to fifteen years old *Evynnis cardinalis* barely corresponds to 5 to 6 years old *Pagrosomus major*.

Ratio of body length to others against the age.

Body length vs. depth. When it is one year old (about 100 mm. in total length), the ratio is about 2.35—2.4, but when it gets more than 2 years old, ratio is almost uniform, 2.0—2.25 and there is hardly any difference between old and young fish. Many are of the ratio of

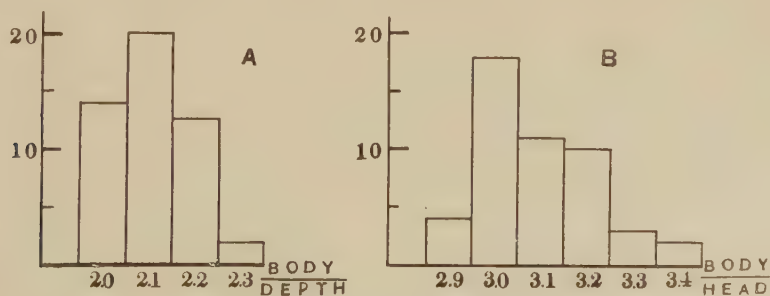


Fig. 3. A Ratio of body length to depth of body, and frequency.

B Ratio of body length to length of head, and frequency.

2.0—2.2, as shown in Fig. 3, A and mostly of 2.1. In *Pagrosomus major* the ratio is 2.2—2.5, so the depth of *Evynnis cardinalis* is naturally deeper.

Body length vs. head length. The ratio is 2.9—3.4, mostly 3.0—3.2 as shown in Fig. 3, B. This is quite the same as that of *Pagrosomus major*. It shows a tendency of decrease in the difference of ratio up to 8 years old, but no change takes place over that age.

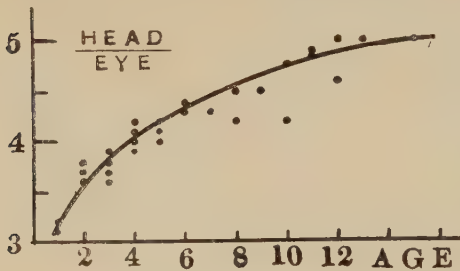


Fig. 4. Ratio of length of head to diameter of eye against the age.

Body length vs. snout. The ratio is 6.5—9 and the difference in the ratio becomes gradually smaller during 2 to 5 years; the ratio is 7 more or less thereafter and does not vary much. This is quite the same as that of *Pagrosomus major*.

In looking over the measurement of the aforementioned parts appended to the present report, it is seen that they differ in many ways. These discrepancies are due to local variations of young and old fishes and no definite subdivision can be established (Cf. Table 1).

Vomerine teeth. An important character in the genus *Evynnis* is that the vomer is toothed, but it is said to possess only a few conical teeth and it was not generally clearly known.

Upon examining 50 specimens, it is found that the variation of the number of teeth is 0—18 and the variation of the number of teeth according to the age is absolutely unrecognizable. The individuals which had no vomerine teeth were four in number: one specimen of 3-year old, two of 4-year old and one 13-year old, corresponding to 8% of the total number.

Body length vs. diameter of eye.

The ratio is 11—15 and the eye becomes smaller as it gets older. The ratio of the body length to the eye is about 13 in 5-year old *Evynnis cardinalis* and *Pagrosomus major* but when they are 10 years old they show more or less difference: the former is 14—15 and the latter is about 16.

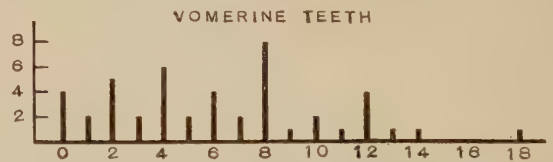


Fig. 5. Number of vomerine teeth and frequency.

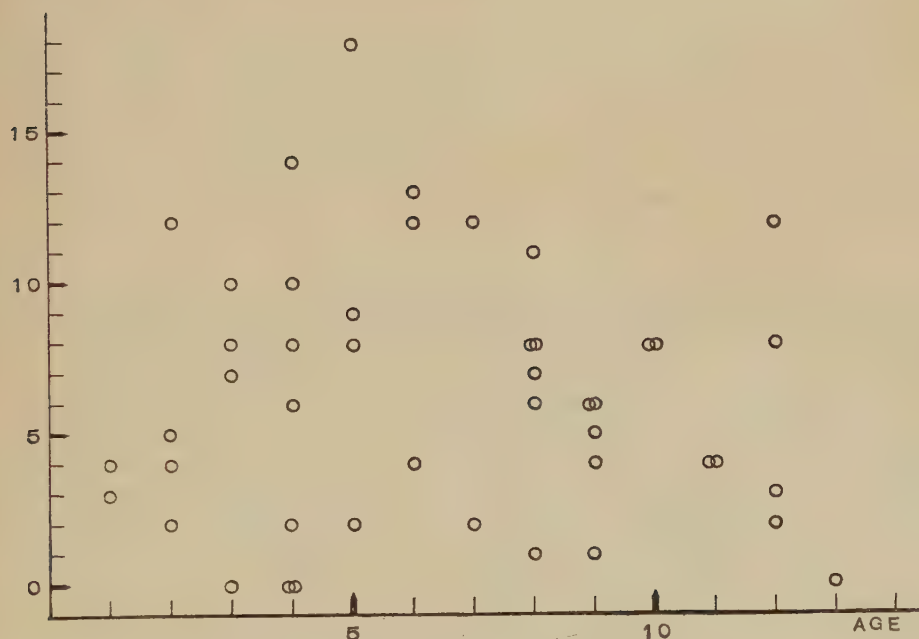


Fig. 6. Number of vomerine teeth against the age.

Premaxillary and teeth. The anterior border of premaxillary, *i.e.*, the distance between the anterior border and posterior border along the rows of teeth, is 10–11 mm. in one year old; 17–18 mm. in 5-year old; 24–25 mm. in 10-year old and about 30 mm. in 13-year old.

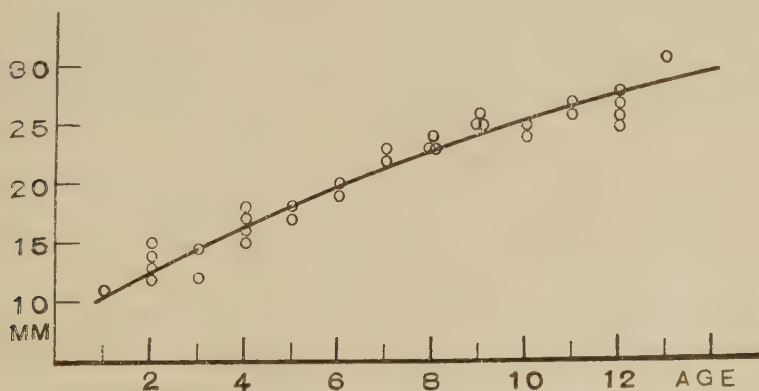


Fig. 7. Length of premaxillary against the age.

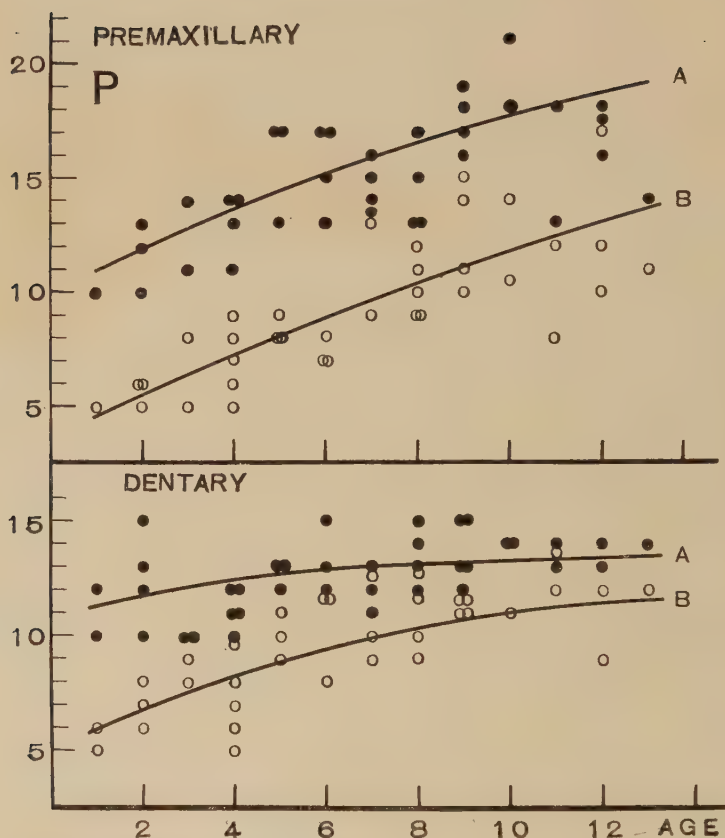


Fig. 8. Number of teeth on inner or outer rows of premaxillary and dentary against the age.

A. Teeth of outer row. B. Teeth of inner row.

There are, as a rule, two canines on one side, but the author has seen, as an exceptional case, two examples with three canines. There are two rows of teeth behind the canine. The tip of the tooth is canine in shape, and, becoming thicker and shorter as it gets toward the back. The anterior border is round or flat and molar in shape, but the difference between them is insignificant. The teeth in the outer row number about 10-14 in 2 to 3-year old fish; 15-17 in the 8-year old and 17-20 in the 12-year old. In the inner row, there are small teeth growing thick immediately back of the canine and there are 5-10 teeth in the back of them. The number of teeth on the inner and outer sides increases with the age (Cf. Fig. 8).

Dentary and teeth. The denticle is nearly as long as maxillary, occasionally 1-2 mm. shorter. The canine in front is always three in number, but the author has seen, as an exceptional case, two specimens with two canines and one with four canines. The teeth in the outer row number 10-15 and show a tendency to increase merely with the age and are not so distinct as those of the maxillary. The teeth in the inner row number 5-12 and show a tendency to increase somewhat.



Fig. 9. The crania of male and female. Supraoccipital bone upheaves extremely and becomes thick in the front in the male as it gets older.

A, female 9 years

B, female 11 years.

C, male 9 years.

D, male 11 years.

Cranium. Supraoccipital bone varies greatly with the age. In one year old specimen, it is extremely thin and transparent, but in 2-3-year old gradually increases in thickness from behind and becomes opaque. It upheaves extremely and becomes thick in the front

as it gets older, especially so in the male. In the female it becomes considerably thick but does not upheave at all.

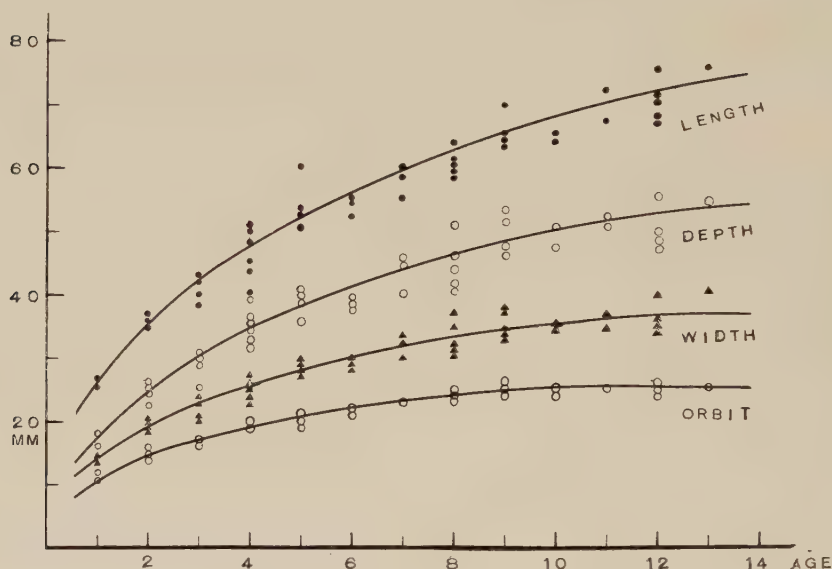


Fig. 10. Length of each part of cranium, against the age.

Frontal bone. There are numerous small holes in the frontal bone just like a sponge, but this bone does not upheave and not fused left to right as in *Pagrosomus major*. According to the investigation of Mr. Tomiyama, the opisthotic bone is invisible. There is no particular variation in the other bones. Increase of the length, depth, and width of the cranium and the orbit is as shown in Fig. 10.

Otolith. The otolith of one year old specimen is 6×4 mm., elliptical in shape and translucent. It is 11×17 mm. in 5-year old and 15×9 mm. in 10-year old. In comparing it with that of *Pagrosomus major*, it has a tendency to lengthen more or less up to 5-year old, but shorten thereafter. The width of the otolith of *Erynnis cardinalis* is broader up to 10-year old and does not grow more than 9 mm. after that, while in *Pagrosomus major* it is still growing gradually even after fifteen years. The weight up to 7-year old is almost the same, but gets lighter after that. The ruggedness of the contour is not so great as in *Pagrosomus major*. The year ring is visible up to 5-6 year

old, but in the older specimen it cannot be seen unless it is sectioned.

Scales. Pored scales in lateral line vary 56—60 in number, 58 being the mode.

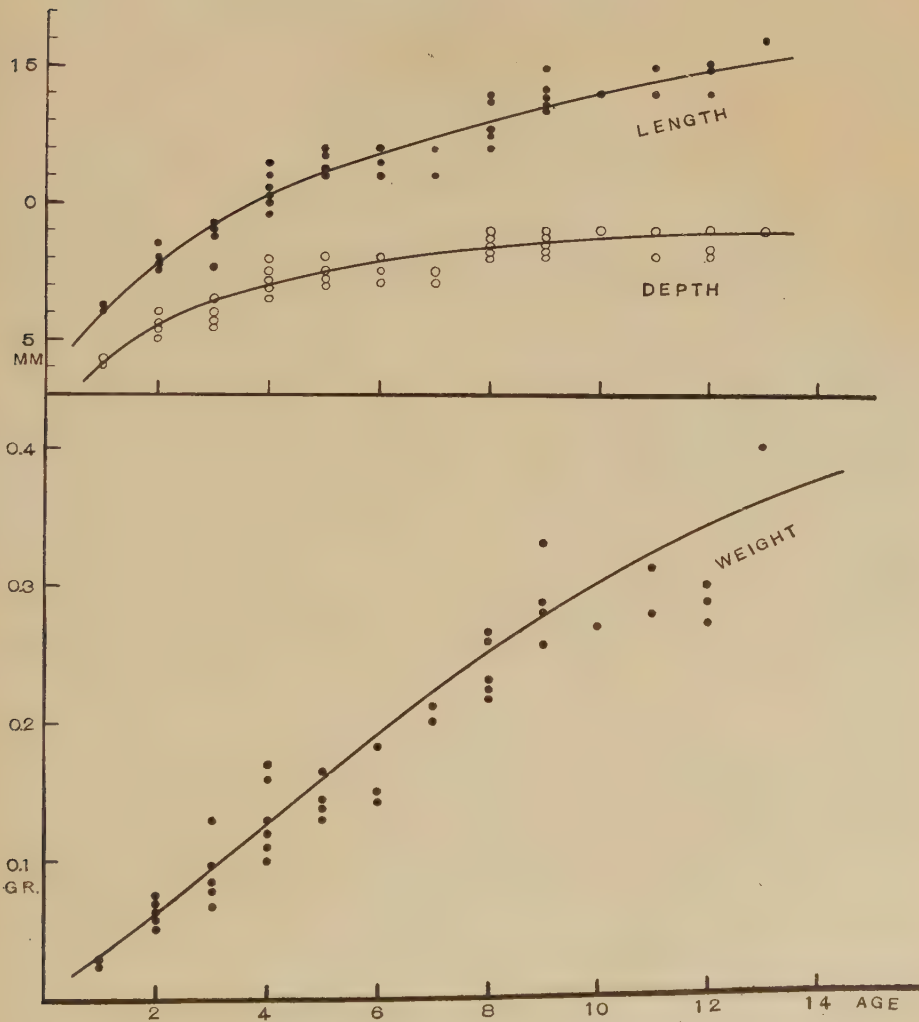


Fig. 11. Length, width and weight of otolith against the age.

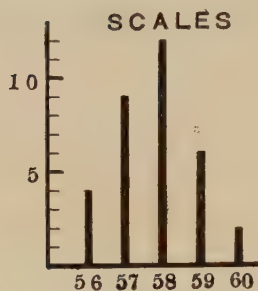


Fig. 12. Pored scales on lateral line and frequency.

Table I.

	Jordan & Thompson	Fowler	Kishinouye	Oshima	Tanaka	Ebina
Depth	$2\frac{1}{3}$	2.2-2.4	—	2.33	$2\frac{1}{3}$	2.1(2.0-2.26)
Length of head	$3\frac{1}{6}$	2.4-3.0	2.5	3.17	3.25	3.0(2.9-3.4)
Length of snout	$2\frac{2}{7}$	$2\frac{3}{5}$ - $3\frac{1}{10}$	—	2.28	2.25	2.4(2.2-3.0)
Diameter of eye	4	3-4	4	4	$4\frac{2}{7}$	3-5
Vomerine teeth	few	several	6-15 (none)	several	2-10 (or without)	0-18
Gill-rakers	7-8+11-12	7-8+9-12	—	7-8+11-12	7-8+9-11	7-8+9-12
Pored scales	$58-64\frac{7}{15-16}$	$51-60\frac{7}{15}$	$51-68\frac{6-7}{13-15}$	$58-64\frac{7}{15-16}$	$54\frac{7}{16}$	$58(56-60)\frac{7}{15-16}$

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Studies on the Scorpaenoid Fishes of Japan.

III. On the External and Internal Characters of *Sebastichthys longispinis* Mihi and *Sebastichthys* *brevispinis*, nom. nov., Compared.*

Kiyomatsu MATSUBARA

(Received Nov. 1, 1935)

In the first instalment, I gave a rather brief description of *Sebastichthys longispinis* Mihi from a specimen closely resembling a species which was called *Sebastichthys elegans* by Jordan and Starks and I outlined the result of my comparative study of the two species noted above.

Dr. Y. Wakiya suggested to me that *Sebastes elegans* described by Steindachner & Döderlein should be synonymized with *Sebastes oblongus* of Günther. Since my careful study on the subject quite agrees with his opinion, I propose a new name *Sebastichthys brevispinis* as a substitute for *Sebastichthys elegans* of Jordan & Starks which proved to be a homonym.

In the present report, I shall give a detailed account of the external and internal characters of the two species aforementioned and also my views from statistical and osteological standpoints.

Among the characteristic lengths of various parts of the body, the length of second anal spine and the longest dorsal spine are the only criteria by which the above-mentioned two species can be distinguished. The measurements of various parts of body are plotted in Figs. 4-6 in reference to body length. Tables 1-2 show the data of 2 to 5 years old individuals of *S. longispinis* and 3 to 5 years old individuals of *S. brevispinis* which constitute the majority of material.

In the following description the length of head is measured from the tip of snout to the end of upper opercular spine.

* Contributions from the Zoological Laboratory, Imperial Fisheries Institute, No. 52. The expense of this work has been partly defrayed by the research fund from "Nihon Gakujutsu Shinkokai" (Foundation for the Promotion of Scientific and Industrial Research of Japan). The second communication appeared in the Bull. Jap. Soc. Scien. Fisheries, 4, (4), 1935.

The author wishes to express his sincere gratitude to Prof. A. Terao and to Prof. M. Tauti for their valuable advices given in the course of this study. He is also greatly indebted to Dr. Y. Wakiya for his valuable suggestion and to Dr. S. Tanaka of the Tokyo Imperial University and to the staff of the Tyôsen Fisheries Experimental Station who were kind enough to loan him many specimens.

Sebastichthys (Pteropodus) longispinis MATSUBARA

Japanese Name: *Kôrai-yoroi*.

Sebastichthys (Pteropodus) longispinis MATSUBARA, 1934, p. 209 (Huzan).

External: Head 2.64 in body length; depth 2.48. Orbit 3.54 in head; snout 4.37; maxillary 2.25; interorbital space 6.90; depth of caudal peduncle 3.01; pectoral 1.26; longest dorsal spine 2.15; penultimate dorsal spine 3.60; second anal spine 1.80; ventral 1.48; caudal 1.43. Dorsal XIII, 13; anal III, 6. Pores of lateral line 26. Gill-rakers on first arch 7+11, the longest one 4.84 in orbit.

Body rather short and deep, the back circularly elevated. Lower jaw a little shorter than upper; maxillary extends to posterior orbital rim; symphyseal knob absent. Teeth small, in moderate bands on jaws, vomer and palatines. Eye rather large, longer than the snout. Interorbital space moderately concave, a pair of curved frontal ridges run near its middle, forming a rather deep canal between them. Cranial spines strong and pungent; nasal, preocular, postocular, tympanic and parietal spines present; supraocular, coronal and nuchal spines absent. Preorbital with two lobes, posterior one ending in a feeble spine. Two upper preopercular spines larger, directed backward; three lower ones smaller, directed downward and backward.

Dorsal spines rather high, fifth one the longest, somewhat shorter than half the length of head; second anal spine longer than third spine or half the length of head. Pectoral reaches vent, its lower 8 rays simple and somewhat thickened. Ventral extends slightly beyond the vent. Caudal truncated.

Scales finely ctenoid; interorbital space, snout, preorbital, maxillary, mandible and branchiostegal membrane naked. Small scales on basal half of median pectoral rays, and basal one-third of dorsal and anal fins.

Color in formalin grayish brown, with four irregularly-shaped dark

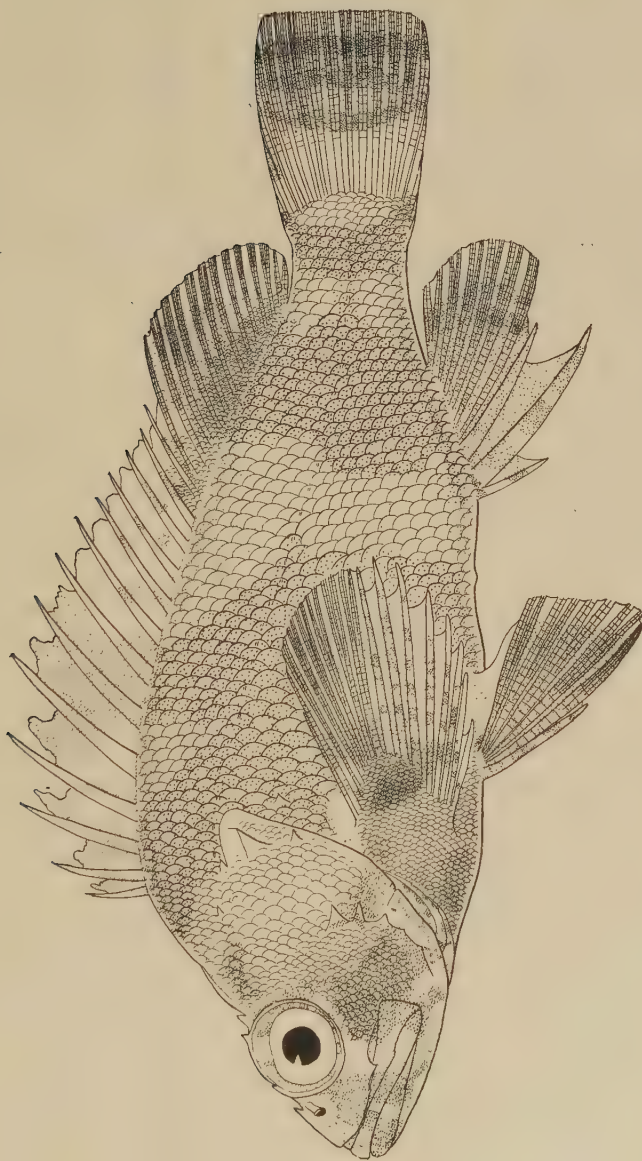


Fig. 1 *Sebastichthys (Pteropodus) longispinis* Matsubara $\times 1$.

cross bands; first from occiput to below third dorsal spine, reaching below lateral line; second under middle portion of spinous dorsal, much widened under lateral line; third below soft dorsal; fourth narrower, at the base of caudal fin, the anterior three bands extending to dorsal fin. Interorbital space, preorbital and cheek, each with a large dark brown blotch. Under side of head irregularly mottled with dark brown. Anterior half and posterior margin of caudal fin, white; posterior half of caudal crossed with four diffuse dark cross bands. Basal two-thirds of anal dark brown, the distal one-third white; ventral colored like anal. Pectoral with three diffuse dark cross bands, the basal one forming a large black blotch.

The above description is derived from a female specimen, 142.5 mm in total length, collected at Huzan, Tyôsen.

Internal: Cranium rather thick and heavy, its depth about 2.37 in its depth, base of cranium nearly straight. Orbit rather large, somewhat shorter than postorbital part of cranium. Ventral process of basisphenoid well developed as a thin paddle-shaped bone, its tip and the upper crest of parasphenoid entirely meeting. Interorbital space very narrow, about 5.7 in length of cranium, widening markedly backward. Supraorbital margin raised; frontal ridges moderate, forming a deep canal between them. The nodules on the prefrontal for the articulations of the preorbital and palatine well developed. Mesethmoid processes strong, directed upward and forward. Parietal bones meeting. Preorbital bone with two angulated lobes, each ending in a rather sharp point. Second suborbital bone very broad and short, tapering posteriorly to a pointed tip, not reaching the upper ridge of preopercle; third and fourth suborbital bones present. Vertebrae $9+16+\text{hypural}=26$; parapophysis developed from sixth vertebra. Posttemporal, supraclavicle and clavicle each provided with a sharp spine at their upper posterior angles. Actinosts are rather large, 3 in number, one and a half are articulated with hypercoracoid and others with hypocoracoid. Postclavicle is in two parts, the posterior one being ray-like. Gill-rakers are tubercular and spinulated.

Air-bladder absent. Peritoneum white. Pyloric caeca 9 in number, rather long, slightly slenderer than intestinal canal.

The above internal description is based upon a female specimen, 151 mm in total length, obtained from Huzan, Tyôsen.

The present species appears to be rather common at Huzan, Si-



Fig. 2. *Sebastichthys (Iteropodus) longispinis* Matsubara $\times 2$
A, B, cranium; C, lower jaw and palate; D, orbital bones; E, shoulder girdle; F, first gill-arch; G, alimentary canal.

monoseki and Wakayama. I procured 77 specimens from the localities noted above and one from Hiroshima.

Sebastichthys (Pteropodus) brevispinis, nom. nov.

Japanese Name: *Yoroi-mebaru*

Sebastes marmoratus (pars) BREVOORT, 1856, p. 260, pl. 4, Fig. 1 (Simoda)

Sebastichthys elegans JORDAN & STARKS, 1904, p. 118, Fig. 6. (Misaki; Onomiti; Miyazima) nec *Sebastes elegans* STEINDACHNER & DÖDERLEIN, 1884, p. 205; FRANZ, 1910, p. 71 (Aburatubo); ? JORDAN & METZ, 1913, p. 51 (Huzan); JORDAN & THOMPSON, 1914, p. 273 (Izu, Yokohama, Simonoseki); TANAKA, 1915, p. 336 (Usitu).

Sebastodes (Sebastocles) elegans JORDAN & HUBBS, 1924, p. 270 (Misaki); SCHMIDT, 1931, p. 99 (Tokyo fish-market).

External: Head 2.47 in body length; depth 2.51. Orbit 3.57 in head; snout 4.28; maxillary 2.48; interorbital space 7.36; depth of caudal peduncle 3.32; pectoral 1.21; longest dorsal spine 2.47; penultimate dorsal spine 3.41; second anal spine 2.24; ventral 1.60. Dorsal XIV, 12; anal III, 6. Pores of lateral line 29. Gill-rakers on first arch 7+13, the longest one 4.4 in orbit.

Body rather deep, its depth about equal to the length of head. Lower jaw included when mouth is closed; maxillary extends to posterior margin of pupil; symphyseal knob not visible. Teeth small, in moderate bands on jaws, vomer and palatines. Eye longer than length of snout. Interorbital space deeply concave; supraorbital margins much elevated; a pair of curved ridges run near the middle of interorbital space, forming a narrow, deep canal between them. Cranial spines stout and pungent; nasal, preocular, postocular, tympanic and parietal spines present, directed obliquely upward; supraocular, coronal and nuchal spines entirely absent. Preorbital with two lobes, the posterior one angulated, ending in a rather sharp point. Three upper preopercular spines larger, directed backward, two lower ones smaller, directed backward and downward.

Dorsal spines rather low, fifth one the longest, much shorter than half the length of head. Second anal spine somewhat longer than the former, but shorter than half length of head. Pectoral extends to first anal spine, its lower 9 rays simple and somewhat thickened. Ventral scarcely reaches the anal. Caudal truncated.

Scales weakly ctenoid; interorbital space, snout, preorbital, jaws and branchiostegal membranes naked; small scales on basal half of

median pectoral rays, and basal one-third of dorsal and anal fins.

Color in formalin dark brown, crossed with four diffused dark cross bands; first from nuchal region to axil of pectoral; the second under middle of spinous dorsal; third under soft dorsal; fourth on base of caudal fin; the anterior three bands extend to dorsal fin. Head dark brown, interorbital space, snout and cheek darker. Dorsal fin dark brown, distal half of soft dorsal crossed with about three irregular crossbands. Caudal dusky, with 6 cross bands, the anterior two fainter. Anal whitish, with 5 diffuse dark brownish cross bands.

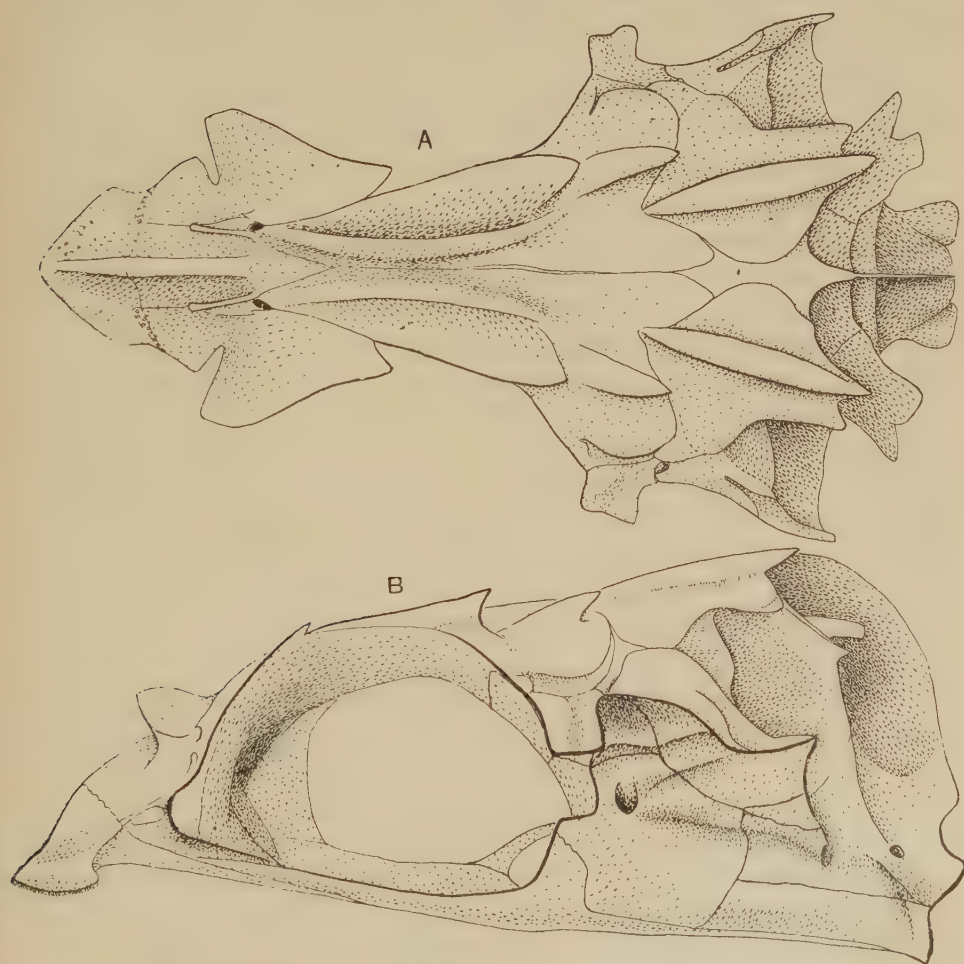


Fig. 3. Cranium of *Sebastichthys* (*Pteropodus*) *brevispinis*, nom. nov. $\times 2\frac{1}{2}$

Pectoral with a large blackish blotch in the basal part of middle rays, followed distally by 4 blackish cross bands. Ventral same as in anal.

The foregoing description is based upon a female specimen 145 mm in total length, from a fish market in Simonoseki.

Internal: Osteological and other internal characters are essentially the same as those of *Sebastichthys longispinis*, but in the present species the parietal bones are entirely separated.

The present species corresponds to the description and figure of *Sebastichthys elegans* of JORDAN & STARKS and of almost all other authors, but differs from original description of STEINDACHNER & DÖDERLEINS' *Sebastes elegans*, which I take to be a synonym of *Sebastichthys oblongus* (GÜNTHER).

STEINDACHNER & DÖDERLEINS' description of *Sebastes elegans* seems to agree with *Sebastes oblongus* of GÜNTHER in the following points:

1. In the description of *Sebastes elegans* STEINDACHNER & DÖDERLEIN note: "Kopfstacheln: n.o." Po. oc," wenig erhaben." These abbreviations mean nasal, postocular, tympanic and occipital spines. There is no species of fish, belonging to the *Sebastichthys* of Japan, that has such cranial armatures, except *Sebastichthys oblongus* (GÜNTHER). The head of JORDAN & STARKS' *Sebastichthys elegans* is not only armed with a strong preocular spine, but also with above-mentioned spines which are strong and pungent.

2. In the description of Steindachner & Döderlein, they also note: "L. Lat. 35 (durchhort)" These characters agree with *Sebastichthys oblongus* (GÜNTHER), but not with JORDAN & STARKS' *Sebastichthys elegans*, in which the pored scales are always less than 30.

3. In examining 44 specimens of *Sebastichthys elegans* of JORDAN and STARKS, I found that they are always armed with 14 dorsal spines but never with 13 spines.

4. In the original description of STEINDACHNER & DÖDERLEINS' *Sebastes elegans* (body length 6.5 cm), they note: "Augendurchmesser ist $3\frac{3}{4}$ mal in der Kopflänge enthalten" This character quite agrees with that of small specimens (6.0–10.0 cm. in body length) of *Sebastichthys oblongus* (GÜNTHER) but not with *Sebastichthys elegans* of JORDAN & STARKS.

The description of *Sebastes elegans* STEINDACHNER & DÖDERLEIN runs: "Augendurchmesser erreicht $\frac{3}{4}$ der Schnauzenlänge, $\frac{3}{5}$ der Stirnbreite." It appears to me that these figures are misprinted and should be read $\frac{4}{3}$ and $\frac{5}{3}$ respectively.

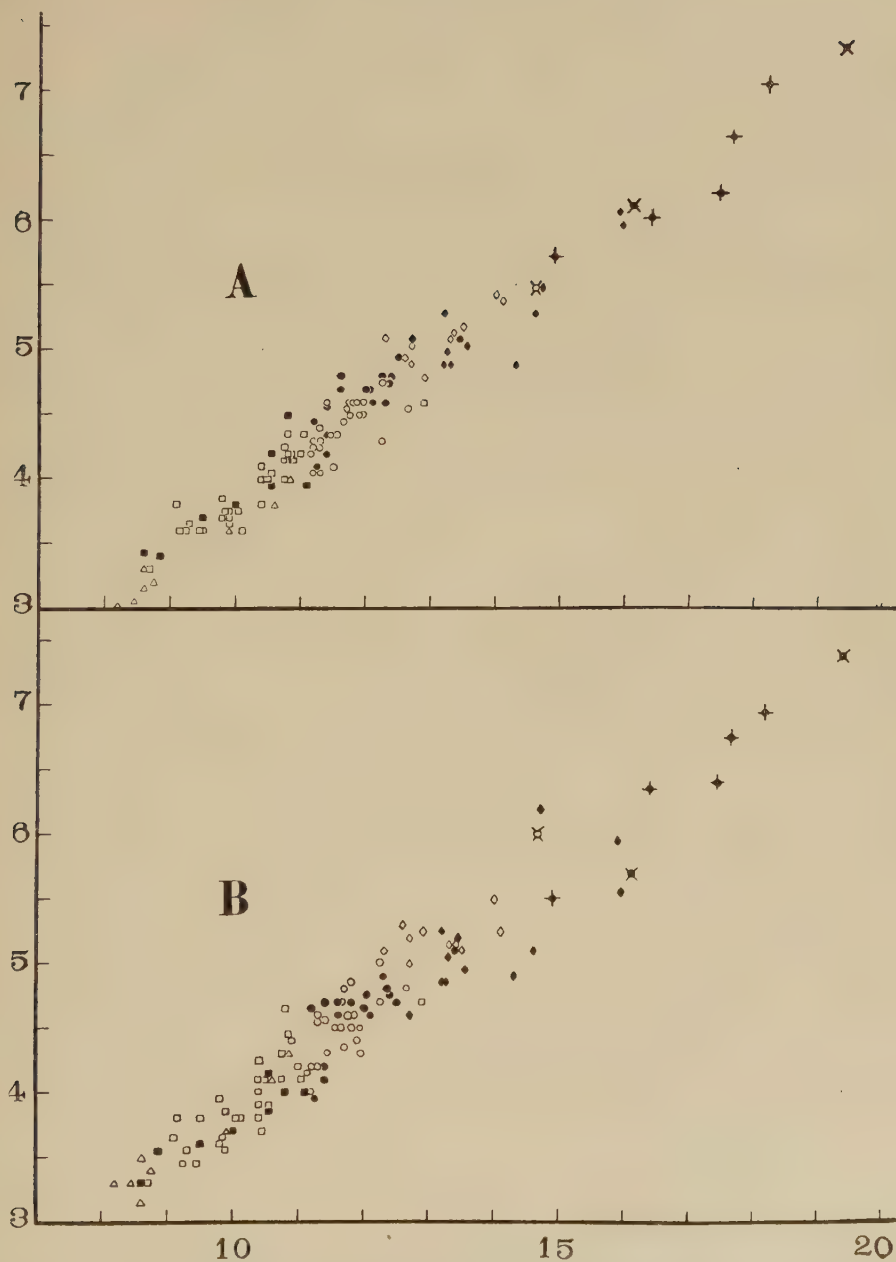


Fig. 4. Showing dimension (in cm) of body parts in relation to body length of *Sebastichthys longispinis* and *S. brevispinis*.

A, length of head; B, depth of body.

S. long. $\triangle$, two years old; $\square$, three years; $\circ$, four years; $\diamond$, five years; $\circ$, six years; $\square$, seven years.

S. brev. $\triangle$, two years old; $\blacksquare$, three years; $\bullet$, four years; $\blacklozenge$, five years; $\blacklozenge$, six years; $\times$, seven years.

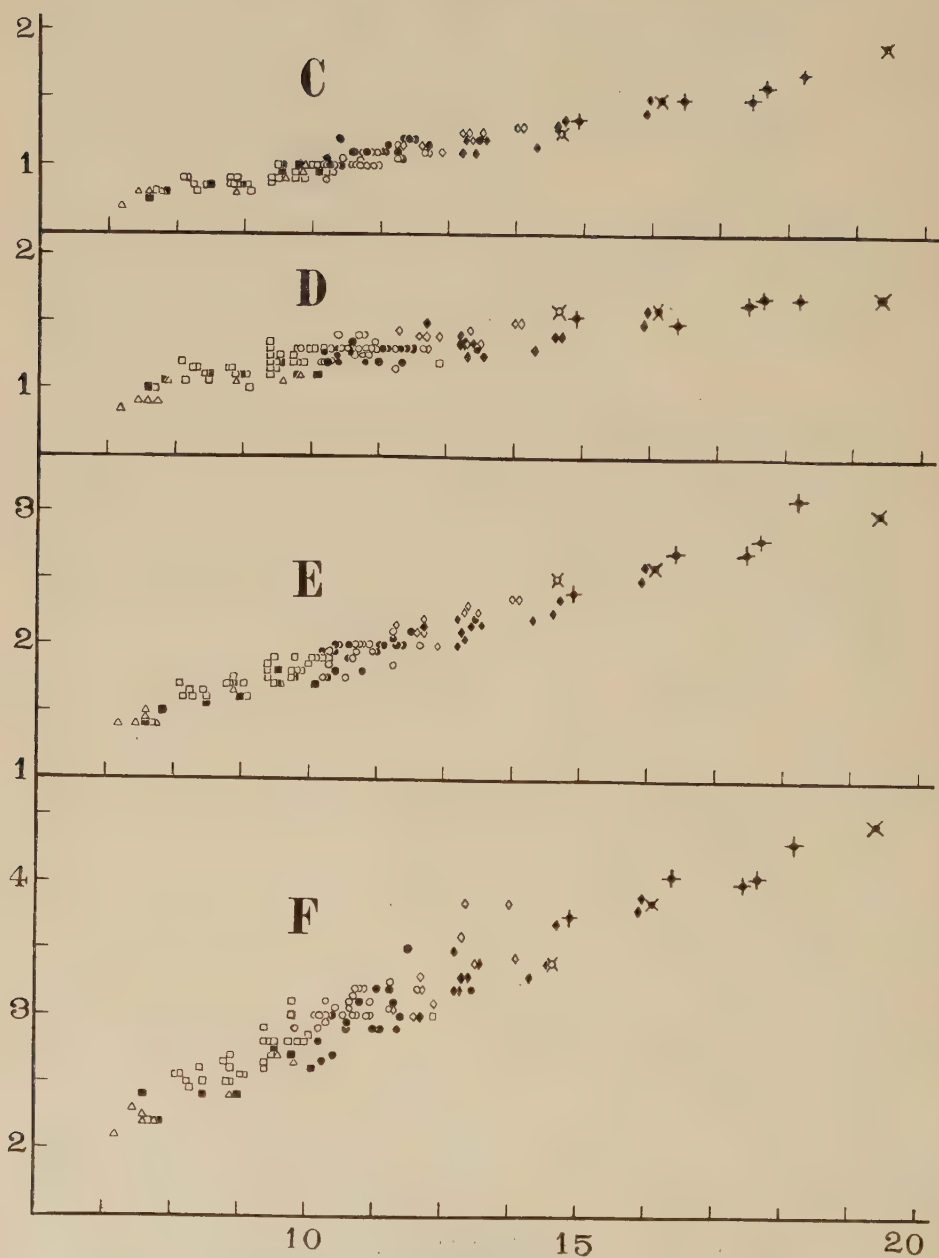


Fig. 5. Same as in Fig. 4 with the same yearly symbols.
C, length of snout; D, length of orbit; E, length of maxillary; F, length of ventral.

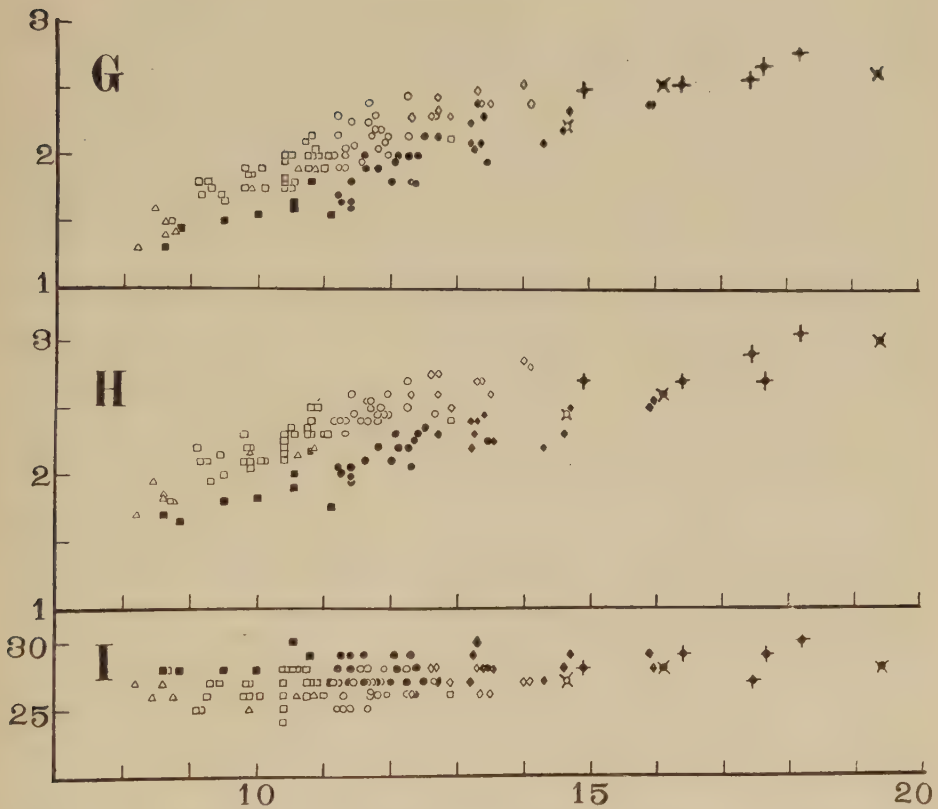


Fig. 6. Same as in Figs. 4 and 5 with the same yearly symbols. G, length of longest dorsal spine; H, length of second anal spine; I, number of scales on lateral line.

The present species appears to be rather common in the south of central part of Japan. I obtained 44 specimens from Huzan, Simonoseki, Yamaguti-ken, Kumamoto, Misaki, Tokyo, Usitsu (Isikawa-ken) and Uodu (Toyama-ken).

Comparison.

As shown in Figs. 4-6, the relative lengths of head, orbit, maxillary, snout, ventral and the depth of body to the body length do not serve for separating the above-mentioned two species, but the following items, if taken all together, answer the purpose considerably well.

1. *Length of second anal spine.* Fig. 6 and Tables 1-2 show that

the two forms may be rather clearly distinguished by the proportional length of second anal spine. In *Sebastichthys longispinis*, the second anal spine is longer than in *Sebastichthys brevispinis*, measuring 1.55 to 2.00 in head and mostly 1.70 to 1.95 in head in 78 specimens of the former 100 to 175 mm long. In 44 specimens of *Sebastichthys brevispinis*, measuring 106 to 234 mm long, the second anal spine varies from 2.00 to 2.50 in head, but it is generally 2.20 to 2.25 in head.

2. *Length of the longest dorsal spine.* In either of these two forms, the fourth or fifth spine is longer than the others. As indicated in figure and tables, *S. longispinis* has a proportionally longer one than *S. brevispinis*, although not so distinctly as is the case with second anal spine. Almost all the 78 specimens of the former have the longest dorsal spine 1.95 to 2.35 in head, but the latter 2.35 to 2.65 in head.

3. *Number of pored scales on lateral line.* As shown in tables, *S. longispinis* has usually 26 to 27 pored scales, but the other is mostly provided with 27 to 29 pored ones, neither having more than 30.

4. *Number of dorsal spines.* In *S. brevispinis* 44 specimens are provided with 14 dorsal spines and only one specimen with 15 spines, but in the other species only 3 specimens out of 77 with 14 spines and the rest with 13 spines.

5. *Coloration.* In *S. longispinis*, the ground-color is generally lighter than the other species, and anterior half of caudal fin and margins of all fins are whitish. In *S. brevispinis*, all the fins are dark and marked with either darker bars or spots.

6. *Characters of parietal bones.* Generally, in *S. longispinis* the parietal bones are meeting. According to my observations of 78 specimens, only 5 larger specimens measuring 138 to 179 mm long have very slightly separated parietals, but other 73 specimens, measuring 100 to 175 mm long, have the parietals entirely touching. On the other hand, in *S. brevispinis* all 44 specimens 106 to 234 mm long are provided with separated parietals, and specimens as large as 138 to 179 mm with their parietals widely separated.

Table I. Frequencies of body proportions of *Sebastichthys*
(*Pteropodus*) *longispinis* Matsubara

Locality: A, Huzan; B, Simonoseki; H, Wakayama; I, Hiroshima.

Age: II, two years, III, three years, IV, four years, and V, five years old.

Locality	Head in body length																								
	2.40-2.50					2.50-2.60					2.60-2.70					2.70-2.80					2.80-2.90				
	II	III	IV	V		II	III	IV	V		II	III	IV	V		II	III	IV	V		II	III	IV	V	
A		2	1	1				13	7	3			11	12	3				2	1					
B								1	1	1			3		1			1	1					I	
H																7	1					2			
I													1												

Locality	Depth in body length																								
	2.35—2.45					2.45—2.55					2.55—2.65					2.65—2.75					2.75—2.85				
	II	III	IV	V		II	III	IV	V		II	III	IV	V		II	III	IV	V		II	III	IV	V	
A		2	1	3			6	7	1		6	6	2					9	8	1			3	1	
B			1						1		2	1	1					3						1	
H	1					3				3	1							1							
I																		1	1						

[illegible]

Locality	Maxillary in head									
	2.10—2.15 II III IV V	2.15—2.20 II III IV V	2.20—2.25 II III IV V	2.25—2.30 II III IV V	2.30—2.35 II III IV V	2.35—2.40 II III IV V	2.40—2.45 II III IV V	2.45—2.50 II III IV V		
A		3	6	8	8	1	1	1		
B			1	2	1	1				
H	1	3	3		3	2				
I		1	1		1					

Table I. (Continued)

Locality	Pectoral in head									
	1.05-1.10	1.10-1.15	1.15-1.20	1.20-1.25	1.25-1.30	1.30-1.35	1.35-1.40	1.40-1.45	1.45-1.50	1.50-1.55
A	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V
B	1	1	9 9	10 8 2	5 4 2	1	2			
H			1 1	1 2	1	1	1			
I			3 3	4 1 1						

Locality	Ventral in head									
	1.30-1.35	1.35-1.40	1.40-1.45	1.45-1.50	1.50-1.55	1.55-1.60	1.60-1.65	1.65-1.70	1.70-1.75	1.75-1.80
A	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V
B	1	2 1	6 8 1	13 10 1	4 4 1	1	1			
H	1		1 1 1	1	2 2 1	1	1			
I			3 1	3 1 1	1 1	1				

Locality	Longest dorsal spine in head									
	1.75-1.85	1.85-1.95	1.95-2.05	2.05-2.15	2.15-2.25	2.25-2.35	2.35-2.45	2.45-2.55	2.55-2.65	2.65-2.75
A	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V
B	1	1	6 8	10 8 5	9 3 3	1	2	1	1	
H			2 1	1	1	2	1	1		
I			1	3 1	1	1	1			

Locality	Second anal spine in head									
	1.55-1.60	1.60-1.65	1.65-1.70	1.70-1.75	1.75-1.80	1.80-1.85	1.85-1.90	1.90-1.95	1.95-2.00	2.00-2.05
A	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V
B		3	1	6 1	11 9	3 7 2	2 4 1	1 1 3		
H			1	3 1	1	1	1	1	2	
I	1			1 1	3 1 1					

Locality	Pored scales on lateral line									
	24	25	26	27	28	29	30	31	32	33
A	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V	II III IV V
B	1	4 4	3	7 8 4	8 7	1	2	1	7	3
H				2 2 1	1	3	1		1	
I				4 3						

Table II. Frequencies of body proportions of *Sebastichthys* (*Pteropodus*) *brevispinis*, nom. nov.Locality: A, Huzan; B, Simonoseki; C, Yamaguti; D, Kumamoto
E, Misaki; F, Tōkyō; G, Usetu.

Age: III, three years, IV, four years, and V five years old.

Locality	Head in body length									
	2.40—2.50		2.50—2.60		2.60—2.70		2.70—2.80		2.80—2.90	
	III	IV	III	IV	III	IV	III	IV	III	IV
A										
B		2		1		1		1		
C					2	1				
D		1								
E				2	1	1				
F	1	1		2	1	2	1	2	1	
G		1								1

Locality	Depth in body length									
	2.35—2.45		2.45—2.55		2.55—2.65		2.65—2.75		2.75—2.85	
	III	IV	III	IV	III	IV	III	IV	III	IV
A										
B		1				1				
C			1	2				3	1	1
D										
E	1							1		
F		1		1	1	1	1		1	1
G			1	2	1	4	1			

Locality	Orbit in head									
	3.20—3.30		3.30—3.40		3.40—3.50		3.50—3.60		3.60—3.70	
	III	IV	III	IV	III	IV	III	IV	III	IV
A										
B			1				1	1		
C										
D								1		
E										
F	1		1				3	1	1	2
G					1					

Table II. (Continued)

[illegible]

Locali- ty	Second anal spine in head											
	1.90-1.95 IIIV	1.95-2.00 IIIV	2.00-2.05 IIIV	2.05-2.10 IIIV	2.10-2.15 IIIV	2.15-2.20 IIIV	2.20-2.25 IIIV	2.25-2.30 IIIV	2.30-2.35 IIIV	2.35-2.40 IIIV	2.40-2.45 IIIV	
A			1		1		2			1		
B		2				1	1	2			1	
C												
D									1			
E	1		1									
F		1	1			1	3	1	2			
G							1					

Locality	Pored scales on lateral line											
	26		27			28			29		30	
	III	IV	V	III	IV	V	III	IV	V	III	IV	V
A					1	1						
B					1				2			
C						1	1			2		
D												
E					1							
F	1				1			1	1			
G					2	2	3	4	2	1		1
						1						

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A Review of Two Genera of the Japanese Sculpins,
Ereunias and *Marukawichthys* with Special
Reference to their Systematic Positions.*

Kiyomatsu MATSUBARA

(Received Feb. 19, 1936)

In 1901 Jordan and Snyder described *Ereunias grillator* as a new genus and species referable to a new subfamily of Cottidae, and maintained that *E. grillator* is closely allied to *Triglops*. Jordan, however, raised in 1923 the subfamily in question to the rank of a family. The present author obtained in 1931 a specimen which bears resemblance to *E. grillator* but erected a new genus and species, *Marukawichthys ambulator*, as a type of a new family. Subsequently diverse opinions have been made public as to systematic positions of *E. grillator* and *M. ambulator* but without founder basis.

In January, 1936 the writer had an opportunity to examine deep sea fishes obtained from Owase, Mie Prefecture at a depth of about 170 fathoms. Among them 49 specimens were found referable to two species aforementioned. Observations on their external as well as internal characters convinced the writer that they represent two distinct species [23 (10 ♂, 13 ♀) referable to *E. grillator* and 26 (18 ♂, 8 ♀) to *M. ambulator*] in spite of doubt raised by some investigators as to whether or not they belong to one and the same species. The present author extended his comparative study to 10 other species which belong to Loricati and are allied to the above-mentioned two, and arrived at the conclusion that the two species are closely allied to *Icelus spiniger*. Hence the inclusion of the two genera *Ereunias* and *Marukawichthys* in the subfamily Ereuninae of Cottidae. But the author does not mean that the cottoid group is a compact one that admits no subdivision.

In the present study, the writer will designate a row of spines on the lateral line of the body as lateral series; a row of spines immediately above it, supero-lateral series; such on the dorsal sides,

* Contributions from the Zoological Laboratory, Imperial Fisheries Institute, No. 54.

dorsal series; corresponding one immediately below the curved portion of lateral line, infero-lateral series; the same beneath it supero-ventral series; and such on the ventral sides, ventral series.

The author has the pleasant duty of acknowledging my indebtedness to Dr. Yoshikazu Matsui, the Chief of the Fisheries Experimental station of Toyohashi, Aichi Prefecture and Mr. Shigeo Masuda, who have kindly loaned him valuable specimens (3 of *E. grillator* and 5 of *M. ambulator*), and, his gratitude is also due to Dr. Arata Terao who has given him an invaluable help in the course of this study.

Ereunias grillator JORDAN & SNYDER

Japanese Name: *Tbri-kajika*

Ereunias grillator Jordan & Snyder, 1901, Proc. Cal. Ac. Sci. (3rd ser.), 2, p. 378 (Misaki); Jordan & Starks, 1904, Proc. U. S. Nat. Mus., 27, p. 331 (same specimen).

External: Head, measured to end of opercular flap, 2.65 in body length; depth 5.05. Orbit 3.09 in head; snout 2.90; maxillary (measured from tip of snout to maxillary end) 2.35; depth of caudal peduncle 10.58; length of caudal peduncle 1.83; pectoral 1.67; upper detached pectoral ray 1.16; lowest detached pectoral ray 2.09; longest dorsal spine (5th one) 2.27; longest dorsal ray (5th one) 1.68; longest anal ray (5th one) 2.57; caudal 1.79. Interorbital space very narrow, 8.11 in orbit. D.X, I-13; A. 11; P. 11+4; lateral line 41.

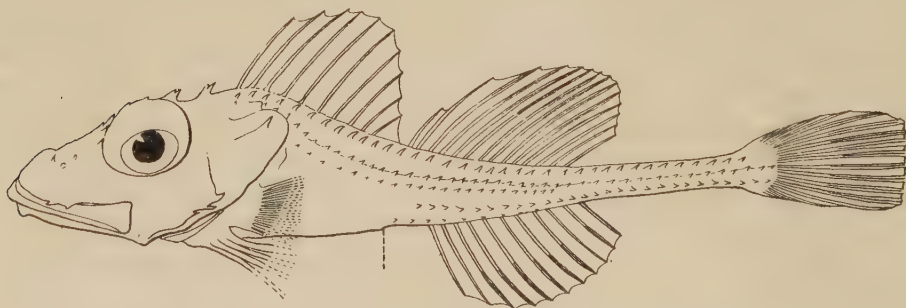


Fig. 1. *Ereunias grillator* Jordan & Snyder $\times \frac{2}{3}$

The hooked spines of the body are composed of five rows, of which the dorsal series 38, lateral series 41, infero-lateral series 22, supero-

ventral series 27, ventral series 17; supero-lateral series entirely absent; the spines of dorsal series are larger, lateral and infero-lateral series are smaller and ventral series rudimentary.

Body rather slender, tapering posteriorly into a long quadrate caudal peduncle; upper profile of head gently elevated to the initial of first dorsal. Head rather large, without quadrate depression in occipital region. Eye rather large, placed high, its upper margin slightly projected above the level of head, its diameter slightly shorter than oblique length of snout and just equal to the length of post-orbital part of head. Mouth horizontal, the lower jaw included when mouth is closed, maxillary nearly reaching beneath the anterior margin of pupil. Suborbital stay rather narrow, its least width about 3 in orbit. Teeth villiform, on jaws, vomer and palatines, the patch of vomerine teeth large, nearly elliptical, expanded laterally. Gill-membranes broadly united, free from the isthmus; no slit behind the last gill-arch. Gill-rakers on first arch 3+11, short, club-shaped; first one on lower limb the longest, about 7.0 in orbit. Pseudobranchiae large. Branchiostegals 6.

Head and body rough, armed with minute prickles. Nasal spines small, but pungent. Lower margin of preorbital provided with two small spines, directed forward and downward. 3 preopercular spines present, upper one the largest, directed backward and slightly upward; second smaller, directed backward and downward; third the smallest, directed backward. Opercular spine obscure. Humeral spine (posterior projection of the clavicle) tubercular, not projected above the skin. Anterior margin of orbit with 3 movable spines, not united with the cranium; upper margin of orbit also armed with 3 spines, the anterior two smaller and movable, the posterior one the largest, given off from the cranium and unmovable, its length contained about 6 times in orbit, forked at tip. Parietal region with a large unmovable forked spine, its length contained about 5.0 times in orbit.

Two dorsals close together, first dorsal lower than the second, spines slender and flexible, fifth the longest; anal lower than first or second dorsal. Caudal truncated. Pectoral fin of two parts, upper with 11 rays, mostly branched and not thickened, extending posteriorly to the beginning of anal fin; the lower with 4 rays, separated from each other, unbranched and thickened, similar to the detached appendages of Triglidae, the uppermost one the longest, extending

posteriorly to base of fourth anal ray. Ventral fin absent.

Color in formalin light blackish gray. Dorsals blackish, each with a whitish median band. Basal half of anal white, the rest of it jet black. Caudal whitish, its basal part and distal margin black. Pectoral dusky, its lower posterior margin black; detached pectoral rays also blackish.

The foregoing description and figures are based upon a male specimen, 291.2 mm in total length, procured off Owase, Mie Prefecture.

Internal: The shape of cranium, the elements composing it, and their arrangement are essentially the same as in the cottoid fish, *Icelus spiniger* Gilbert.

Cranium very slender, its depth at the center of orbit about 4.82 in its length; its greatest depth 4.12; interorbital space very narrow, 17.57; diameter of orbit 2.10; postorbital part of cranium 5.0. Base



Fig. 2. Cranium of *Breunias grillator* Jordan & Snyder $\times 1\frac{7}{8}$

of cranium straight, gently concave at the ethmoidal region.

Vomer, ethmoid, and inner one-third of the prefrontal are cartilaginous; the patch of vomerine teeth elliptical, expanded laterally; the mesethmoid processes ossified, very small, directed forward and slightly upward. Prefrontal pierced by the olfactory nerve. Lateral expansion of prefrontal curved downward. Frontals very narrow, slightly concave, tunneled longitudinally by a pair of large sensory canals, bearing a large spine on their postero-lateral margins; frontal ridges absent; ventral expansions of frontals are meeting along nearly their whole length. Parasphenoid straight, sending out a small brace upward from each side of the anterior edge of prootic. Alisphenoids are remote from each other. Basisphenoid absent. The myodome very shallow, not opening posteriorly, basis cranii (inner lateral expansions of prootics) extending anteriorly to the usual position of basisphenoid as in other mail-cheeked fishes. Exoccipitals very small, forming only the lower border of foramen magnum. Supraoccipital interposed posteriorly between the epiotics, its lower posterior margin bordered with opisthotics and remote from the exoccipital. Supraoccipital ridge entirely absent. Opisthotic extraordinary large and surrounded by exoccipital, basioccipital, prootic, pterotic, epiotic and supraoccipital, forming the upper margin of the foramen magnum. The vague foramen in the opisthotic (not in exoccipital as in other mail-cheeked fishes) rather large. Epiotic is a pyramidal bone, wedged in between pterotic and supraoccipital, connected posteriorly with a large opisthotic and provided with a rather large articular surface for the articulation of the upper branch of the posttemporal. Parietals entirely separated, each with a large forked spine. The remaining cranial elements are as typical as those of the majority of mail-cheeked fishes.

Hyomandibular long, with two heads, the anterior one articulated with upper lateral socket of sphenotic and posterior one sunk into the anterior lateral edge of pterotic. It sends a narrow branch to the metapterygoid which occupies a space between the lower end of hyomandibular and the quadrate; the posterior end of hyomandibular articulated with slender symplectic, which is tapering posteriorly and ankylosed to the inner surface of the quadrate. Quadrate sends out a round head anteriorly for the articulation with the lower jaw. Mesopterygoid very small and round, nearly rudimentary, but situated in usual position between the lateral margins of palatine and metaptery-

goid and connected with the small pterygoid below. It should be mentioned that the anterior edges of palatine and preorbital strongly ankylosed and their antero-lateral edges are also attached to the lower edge of prefrontal. Palatine with a rather broad patch of villiform teeth. Anterior portion of preopercle is sunk in a groove in the hyomandibular; it is tunneled by a large sensory canal, with four lateral foramina at nearly equidistances. Preopercle with three distinct spines, upper one the longest, curved slightly upward. Opercle with a feeble spine posteriorly. Subopercle and interopercle very narrow. Angular is very small and articulated with the lower posterior angle of articular which is rather firmly articulated with dentary. Dentary with rather broad bands of villiform teeth, but much narrower than that of the premaxillary.

Posttemporal is forked, the upper limb jointed with upper ridge of epiotic and lower fork with posterior angle of pterotic in the usual way. Supratemporal is a tunneled dermal bone, situated in front of posttemporal, quadrate, shallowly forked anteriorly, provided with a small, sharp spine on the central portion, directed upward. Upper part of supraclavicle and clavicle each with a small, tubercular projection, not projected on the skin. Postclavicle composed of an upper and a lower elements, the former is stronger and ray-like, the latter minute and pin-shaped. Hypercoracoid pierced by a very large, elliptical foramen. Actinosts large, four in number, two of which are articulated with hypercoracoid and the others with hypocoracoid, middle two larger, partly intervening in the cartilaginous part between hypercoracoid and hypocoracoid. A rather large foramen between upper two actinosts. The detached pectoral rays are articulated with the edge of the lower two actinosts; upper three rays articulated directly with hypercoracoid.

Pelvic girdle distinct and very small, though there are no trace of ventral fin. Pelvic girdle boat-shaped, flattish, shallowly concave, and slightly widened posteriorly, forming a sharp projection on each side; posterior edge is acute; anterior one-third connected with the inner anterior surface of clavicle. Lower surface of pelvic girdle with a median and also a pair of lateral ridges, from the posterior part of the median ridge sending a minute spine anteriorly.

Hyoid apparatus typical as in percoid fishes and other mail-cheeked fishes. Branchiostegal rays 6 in number, 4 of which articulated with

ceratohyal and the rest with epihyal. The rays become progressively larger posteriorly.

Branchial arches cartilaginous. Three united basibranchials present; first is short, articulating with the hypobranchials of first arch, second three times as long as first, its posterior one-third articulating with the hypobranchials of second arch; third basibranchial nearly as long as second, to which the quadrate hypobranchials of third arch are attached. Between the inner edges of hypobranchials of third arch is interposed a rhombic cartilaginous basibranchial (not articulated with third basibranchial), to which the ceratobranchials of fourth gill-arch are attached; hypobranchials of that arch absent. Second and third arches bear toothed upper pharyngobranchial, the former much larger than the latter. First and fourth arches toothless. Lower pharyngeals meet anteriorly, not coossified.

Vertebral formula $14+24+\text{hypural}=39$. The neural spine of atlas not coossified with the centrum. Ribs very feeble, sessile on the vertebrae, not borne on parapophysis, which is very small, rudimentary, and directed downward.

Preorbital and two smaller suborbitals present, jointed firmly with each other, forming a distinct suborbital stay. Preorbital very large, triangular, its lower margin provided with two small spines, directed downward and forward; the first and second suborbitals smaller, the posterior one elongated posteriorly, firmly attached to the upper ridge of preopercle; third and fourth or fifth suborbitals entirely absent.

Nasals small, firmly attached to the mesethmoid processes.

The foregoing osteological characters are based upon a male specimen, 233.5 mm in body length, secured off Owase, Mie Prefecture.

Localities: Owase; Kôti; Suruga Bay.

Marukawichthys ambulator Mihi

Japanese Name: *Marukawa-kajika*

Ereunias grillator SCHMIDT, 1928, Compt. Rend. l'Acad. Sci., p. 319 (Misaki);

SCHMIDT, 1931, Transac. Pac. Comm. Acad. Sci., 2, p. 119 (same specimen).

Marukawichthys ambulator SAKAMOTO, 1931, Jour. Imp. Fish. Inst., 26-2, p. 54 (Toyama Bay).

External: Head, measured to end of opercular flap 2.73 in body

length; depth 4.44. Orbit 2.63 in head; snout 3.07; maxillary (measured from tip of snout to maxillary end) 2.96; depth of caudal peduncle 11.00; length of caudal peduncle 1.67; pectoral 1.61; upper detached pectoral ray 1.15; lowest detached pectoral ray 2.31; longest dorsal spine (second one) 2.86; longest dorsal ray (fifth one) 1.68; longest anal ray (fifth one) 2.46; caudal 1.87. Interorbital space narrow, 4.85 in orbit.

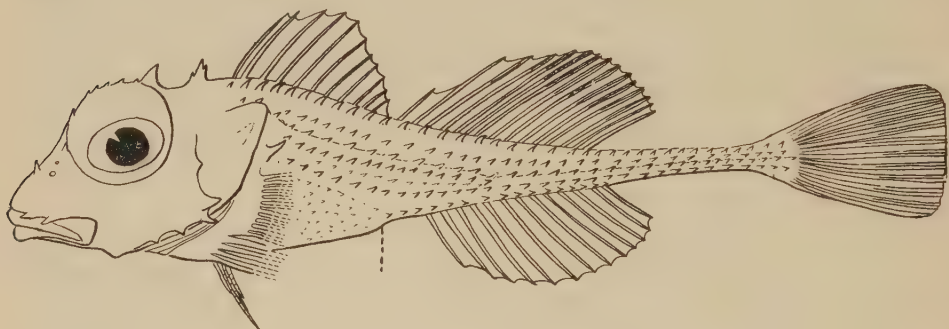


Fig. 3. *Marukawichthys ambulator* Mihi $\times \frac{3}{4}$

D. X, 1-13; A. 13; P. 11+4; lateral line 33.

The hooked spines of the body are composed of six rows, of which the dorsal series 36, supero-lateral series 33, lateral series 33, infero-lateral series 16, supero-ventral series 33, ventral series 27; a row of minute spines between infero-lateral and supero-ventral series and other minute spines are scattered over the pectoral region; the spines of dorsal series are larger.

Head and trunk are rather plump, tapering posteriorly into a long quadrate peduncle; upper profile of head very steep from tip of snout to anterior margin of orbit. Head rather large, with a rather shallow, quadrate depression in the occipital region. Eye very large, larger than oblique length of snout or the length of postorbital part of the head. Mouth horizontal, rather small, the maxillary not reaching to the anterior margin of pupil; lower jaw included when mouth is closed. Suborbital stay rather narrow, its least width about 3 in orbit. Teeth villiform on jaws, vomer and palatines; vomerine teeth arranged only in one or two series on the anterior margin. Gill-membranes broadly united, free from the isthmus; no slit behind the last gill-arch. Gill-

rakers minute, tubercular, 3+9 on first gill-arch. Pseudobranchiae slender. Branchiostegals 6.

Head and body covered with a velvety shargreen. Nasal spines small and sharp. Lower margin of preorbital armed with 2 strong, sharp spines, directed forward and slightly downward. Preopercular spines 5, uppermost one small, second the largest, directed backward, third somewhat smaller, directed backward and slightly downward, fourth and fifth small, directed downward. Opercular spine rudimentary. Humeral spine long and pungent, about 4.5 in orbit, directed backward and upward. Anterior margin of orbit armed with 3 small movable spines; upper margin of orbit with a strong unmovable spine posteriorly, and with several small movable spines in front of it. Parietal region with a strong, unmovable forked spine, its length contained about 5.0 times in orbit.

Two dorsals close together; first lower than second or anal fin, of slender and flexible spines; second the longest; second dorsal higher than first or anal fin, fourth or fifth the longest. Caudal truncated. Branched pectoral fin extending between vent and initial of anal; upper detached pectoral ray reaching third anal ray. Ventral fins distinct, with one spine and four rays.

Color in formalin pale grayish brown, diffused with several dark cross bands; dorsal pale brown, first dorsal with 3 dark cross bands, the outer one darker; second dorsal fin with 7 dark bands; anal black, with median longitudinal white bands; pectoral pale brown, with five black cross bands, narrower than interspace, but absent on the detached rays.

The above description and accompanying figure are based upon a male specimen, 163mm in total length secured off Owase, Mie Prefecture.

Internal: Cranium very plump and high, its depth at the center of orbit about 3.0 in its length; its greatest depth 2.60; interorbital space 11.90; postorbital part of cranium 4.10; diameter of orbit 2.05. Base of cranium deeply concave in the anterior part of it. Teeth on vomer very small, villiform, arranged in one or two series, irregularly arranged at the anterior margin. Five preopercular spines distinct, second the largest. Humeral spine long and pungent. Vertebral formula 13+21+hypural=35. Eggs large, the largest 3.0 mm in diameter. Other characters are essentially the same as in *Ereunias grallator* Jordan & Starks.

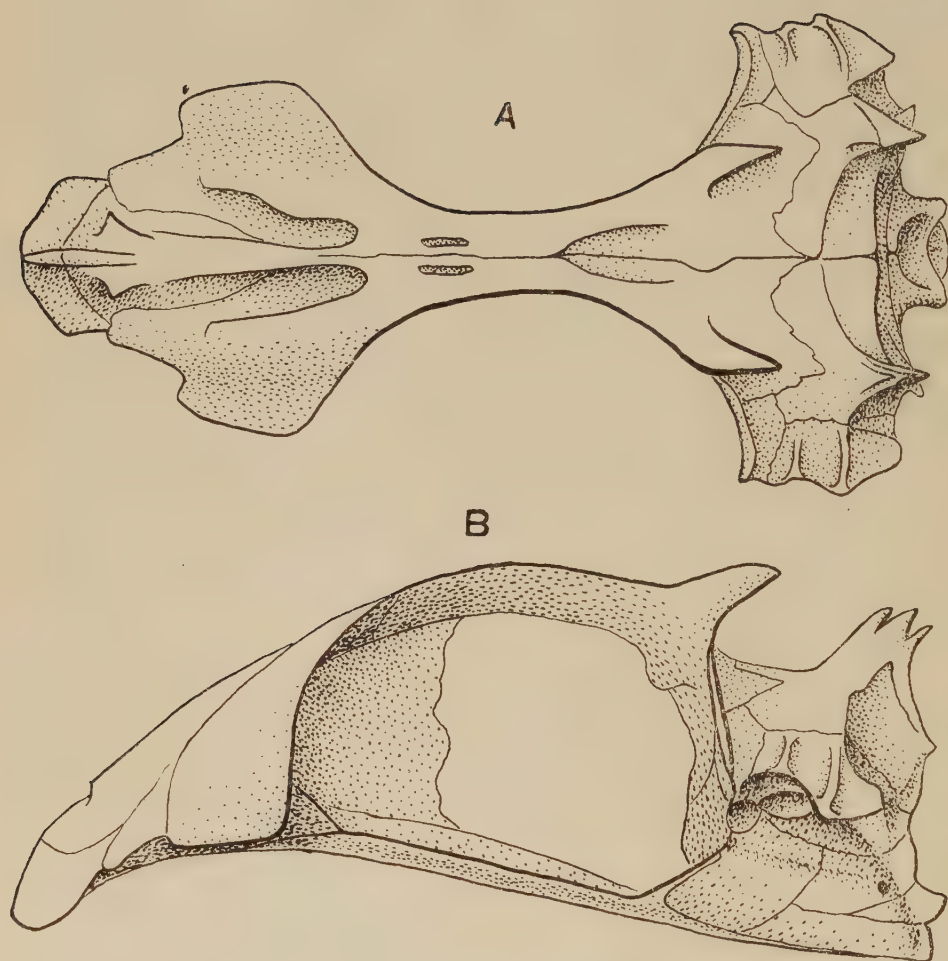


Fig. 4. Cranium of *Marukawichthys ambulator* Mihi $\times 3\frac{1}{2}$

The above internal description is drawn from a specimen 170.5 mm in total length, procured off Owase, Mie Prefecture.

Localities: Owase; Kôti; Tôkyô Bay; Mito; Toyama Bay.

Comparison.

In Figs. 5-8 are plotted 26 (12 ♂, 14 ♀) specimens of *Ereunias grillator*, (measuring 104 to 325 mm long) and 31 (12 ♂, 11 ♀) specimens of *Marukawichthys ambulator* (measuring 140 to 187.5 mm long) in regard to a



Fig. 5. Showing dimension (in cm) of body parts in relation to body length of *Ereunias grillator* and *Marukawichthys ambulator*. A, length of head; B, depth of body; C, length of snout; D, diameter of orbit. Individuals marked with ●, *E. grillator*; ○, *M. ambulator*.

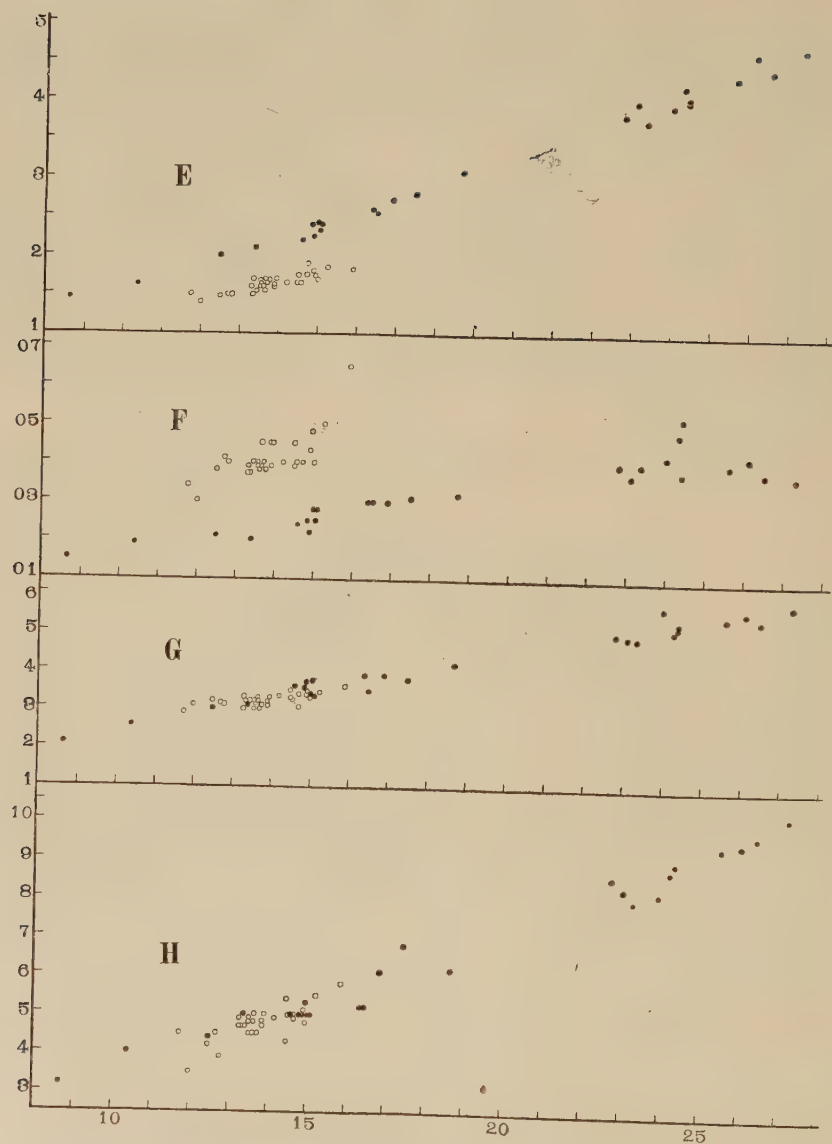


Fig. 6. Same as in Fig. 5 with same specific symbols. E, length of maxillary; F, width of interorbital space; G, length of caudal peduncle; H, depth of caudal peduncle.

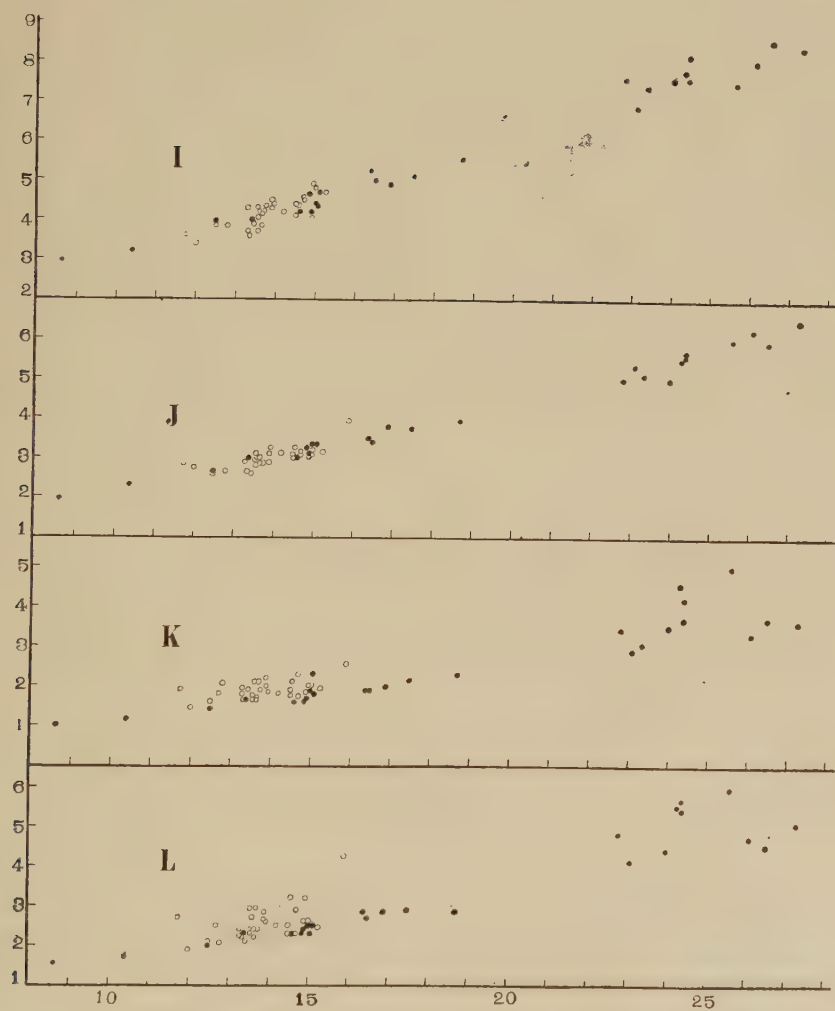


Fig. 7. Same as in Figs. 5 and 6 with same specific symbols. I, length of upper detached pectoral ray; J, length of pectoral fin; K, length of longest dorsal spine; L, length of longest dorsal ray.

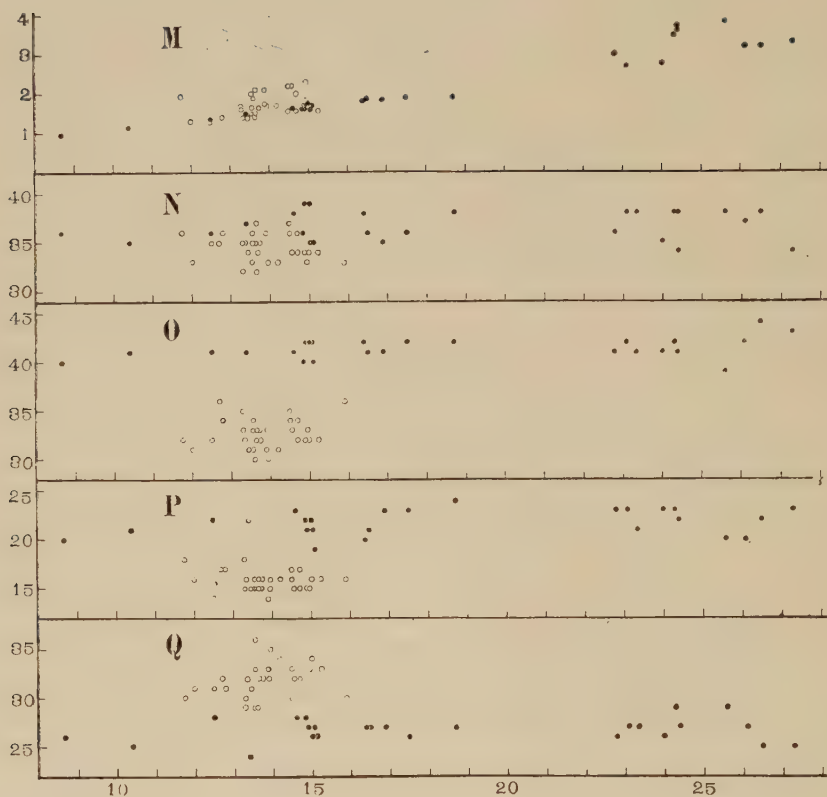


Fig. 8. Same as in Figs. 5, 6, and 7 with same specific symbols. M, length of longest anal ray; N, number of spines on dorsal series of body; O, number of spines on lateral line series; P, number of spines on infero-lateral series; Q, number of spines on supero-ventral series.

number of characters. Among them the relative length of head, snout, orbit, length of caudal peduncle, depth of caudal peduncle, upper detached pectoral ray, pectoral, longest dorsal spine, longest dorsal ray and longest anal ray to the body length, and the number of spines of dorsal series do not serve for separating the two species noted above. But by the following characters they can easily be distinguished one from the other.

1. *Length of maxillary (from tip of snout to maxillary end).* The two forms may be easily distinguished by the relative length of maxillary to the body length. The maxillary is quite longer in *Ereunias grillator* than in *Marukawichthys ambulator*, measuring 2.23 to 2.51 in head, mostly 2.25 to 2.36 in the former but 2.79–3.19 in head, 2.93 to 3.10 for the majority of specimens of the latter.

2. *Width of interorbital space.* *Ereunias grillator* has the interorbital space narrower than *Marukawichthys ambulator*, namely, 17.50 to 28.35, mostly 20.0 to 24.0 in head, whereas 8.69 to 13.67, usually 11.0 to 12.0 in head in the latter species.

3. *Number of rows of spines.* In *Ereunias grillator*, the spines of lateral side of body composed of five rows, viz., dorsal, lateral, infero-lateral, supero-ventral and rudimental ventral series (in many specimens the last series is entirely absent); supero-lateral series entirely absent in all. But *Marukawichthys ambulator* is provided with well developed supero-lateral series in addition to the above-mentioned five rows.

4. *Number of spines of lateral series.* In *E. grillator*, the number of spines of lateral series varies from 39 to 44, generally 41 to 42. But *M. ambulator* is provided with 30 to 36 spines, mostly 31 to 34.

5. *Number of spines of infero-lateral series.* The number of spines of infero-lateral series ranges from 19 to 24, mostly 20 to 23 in *E. grillator*, but 14 to 18 spines, mostly 15 to 17 in *M. ambulator*.

6. *Number of spines of supero-ventral series.* It is fewer in *E. grillator*, measuring 24 to 29, mostly 26 to 27. *M. ambulator* is provided with 29 to 36 spines, generally 30 to 33.

7. *Humeral spine.* This spine (posterior projection of the clavicle) tubercular in *E. grillator*, not projected on the skin, so that it can not be seen without dissection; but in the latter it is strong, pungent, and projected on the skin.

8. *Number of preopercular spines.* This number amounts to three in *E. grillator*, but five in *M. ambulator*.

9. *Ventral fin.* It is entirely absent in *E. grillator*, but distinctly

present in *M. ambulator*.

10. *Profile of head.* Upper profile of head is gently elevated to the initial of first dorsal in *Ereunias grillator*, but in *Marukawichthys ambulator* it is very steep from tip of snout to anterior margin of orbit.

11. In *M. ambulator*, the head is provided with a rather shallow quadrate depression in occipital region, but is not in *E. grillator*.

12. *Coloration.* In *E. grillator*, the pectoral dusky, its lower posterior margin black; the dorsals jet black, each with a whitish median band. In *M. ambulator*, the pectoral pale, crossed with five cross bands, narrower than interspace; first dorsal with 3 dark cross bands, the outer one darker; the second dorsal with 6 or 7 dark bands.

13. *Shape of cranium.* The cranium is very slender, its greatest depth 4.12 in its length in *E. grillator*, but it is short and plump, 2.60 in its length in *M. ambulator*.

14. *Vertebral formula.* The vertebral formula is $14+24+\text{hypural}=39$ in *E. grillator* but $13+21+\text{hypural}=35$ in *M. ambulator*.

Systematic position

Ereunias grillator was put on record as a new genus and a new species and included in a new subfamily Ereuninae by Jordan & Snyder¹⁾ in 1901, on the basis of a specimen, measuring 305 mm in entire body length, which was taken at a depth of 290 fathoms off the coast of Misaki. They referred it to Cottidae and treated it as a species closely allied to *Triglops*. In 1904, Jordan & Starks²⁾ reproduced the description and figure noted above and also placed it under Ereuninae and included it in Cottidae. Then, in 1923 Jordan³⁾ created a new family for this species and named it Ereunidae and placed it in the series of Cottiformes.

The description given by Schmidt⁴⁾ in 1928 under the name of *Ereunias grillator* from a specimen obtained off Misaki quite agrees with my description of *Marukawichthys ambulator* (1931), which was chosen by me as the type of a new family (Marukawichthidae). In 1931, Schmidt⁵⁾ referred to *Ereunias grillator* a specimen which appears to me identical with *M. ambulator* and included it in Triglidæ.

In 1932, Mukerji⁷⁾ also employed in his report the name Ereuninae created by Jordan & Snyder,¹⁾ and treated it as a subfamily of Cottidae and included in it the two genera, *Marukawichthys* and *Ereunias*, on the

basis of the descriptions by Jordan & Snyder,¹⁾ Jordan & Starks,²⁾ Jordan,³⁾ and Sakamoto⁶⁾

It appears to me that such confusion and difference of opinions as noted above are largely due to the fact that a comparative study has not been made with a sufficient number of specimens of two forms since they are relatively rare species. It appears that Schmidt may have thought that *Ereunias* is a genus of Triglidae, as both *Ereunias* and *Marukawichthys* closely resemble to *Lepidotrigla* in having detached pectoral rays and rows of dorsal spines along the base of dorsal. My osteological study of *Chelidonichthys kumu*, the representative species of Triglidae resulted in finding that the basisphenoid is well developed and attached to parasphenoid in *C. kumu*; myodome extends posteriorly, its posterior end being perforated between parashenoid and basioccipitals; nasal bone, supratemporal and posttemporal bones are attached to cranium, each forming a part of cranium and preorbital and suborbitals are attached with each other, forming a strong and perfect suborbital stay. In all these respects *C. kumu* does not seem so closely related to *Ereunias* and *Marukawichthys*.

Besides this, upon examining the skeletons of *Hexagramos otakii*, the representative of Hexagramidae, *Platycephalus indicus*, the representative of Platycephalidae, *Sebastodes inermis*, *Sebastichthys pachycephalus*, *Sebastiscus marmoratus*, *Scorpaena neglecta*, *Apistus evolans*, the representatives of Scorpaenidae, I found that these species are different from *Ereunias* and *Marukawichthys* by the following points: basisphenoid present; ribs are growing out of parapophysis; myodome opens externally between parasphenoid and basioccipitals, with the exception of *Platycephalus indicus*.

Again, my osteological studies of *Gymnocanthus herzensteini* and *Icculus spiniger*, the representatives of Cottidae, resulted in finding these species very closely allied to *Ereunias* and *Marukawichthys* in the following respects:

- 1) Basisphenoid is entirely lacking.
- 2) Myodome is very shallow and does not open posteriorly.
- 3) Supraoccipital crest, which extends to median approximation of opisthotics, is absent.
- 4) Actinosts large, especially the second and the third are larger and partly intervening in the cartilaginous part between hypercoracoid and hypocoracoid.
- 5) Ribs are very feeble, sessile on vertebrae, not borne on parapophysis.
- 6) Parapophysis is extremely small and rudimentary.

Moreover, *Ereunias* and *Marukawichthys* possess the following characters, which are in common with *Icelus spiniger*:

- 1) There are regular rows of spines on the sides of the body.
- 2) Vomer, ethmoid and inner part of prefrontals are not ossified.
- 3) Opisthotic is remarkably large and is surrounded by exoccipital, basioccipital, prootic, pterotic, epiotic and supraoccipital, forming the upper margin of foramen magnum.
- 5) Consequently, unlike the other mail-cheeked fishes, the vagus foramen is absent on exoccipital, but it opens on opisthotic.

In short *Ereunias* and *Marukawichthys* are not substantially different from *Icelus spiniger*, except that the former two possess detached pectoral rays. I would like, therefore, to strike out Ereunidae and Marukawichthidae and retain each of *Ereunias* and *Marukawichthys* as a member of Ereuninae and treat each as species very closely allied to Icelinae and include all of them in Cottoid group.

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A New and a Rare Ophidioid Fishes from Japan.*

Kiyomatsu MATSUBARA

(Received Feb. 19, 1936)

In January, 1936 the present author secured a number of specimens of ophidioid fishes off Owase, Mie Prefecture, at depths ranging from about 80 to 160 fathoms. They are referable to 10 species, two of which deserve special attention. One appears to be new to science and is described here under the name of *Lycodes caudimaculatus*. The other is a very rare species, *Pyramodon ventralis* Smith & Radcliffe, known from Dutch East Indies at a depth of 250 fathoms. Since the systematic position of this species is still an open question, a detailed account of the specimens at my disposal is given in the present paper, together with some comments on generic as well as family characters.

It is the author's pleasant duty to return herewith his gratitude to Prof. A. TERAO for his kind supervision, under which the present study was carried out.

Lycodes caudimaculatus, sp. nov.

D. 99; A. 84; P. 19; V. 3.

Head 6.04 in total length; depth 10.51; distance from origin of ventral to anal 4.53. Eye 3.63 in head; snout 3.41; maxillary 2.51; interorbital space 4.16; postorbital part of head 2.13; pectoral 1.75; ventral 5.50; longest dorsal ray 2.97; longest anal ray 5.00.

Body greatly elongate, compressed, tapering into a pointed caudal. Head somewhat depressed, quadrate in cross section, nearly as deep as wide, its sides vertical,

Mouth rather small, maxillary extending to somewhat beyond the anterior margin of pupil. Lower jaw entirely included under the upper jaw which is projecting beyond the lower for a distance equal to about half the length of eye. Lips thickened. Teeth present on jaws, vomer and palatines; those on premaxillaries and lower jaw irregularly ar-

* Contributions from the Zoological Laboratory, Imperial Fisheries Institute, No. 55.

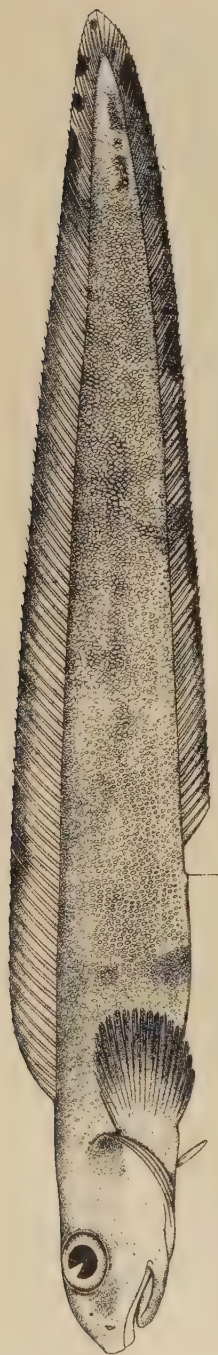


Fig. 1. *Lycodes caudimaculatus*, sp. nov. $\times \frac{8}{7}$

ranged in a rather broad band anteriorly but in a regular single series posteriorly. Palatine teeth in very narrow band.

Anal inserted under 20th dorsal ray.

Lateral line decurved downward and backward from nape to scarcely beyond middle of pectoral.

Head, nape, pectoral and axil naked; trunk, tail and fins with separately embedded scales.

Color in formalin light brownish gray, paler below, head darker; dorsal and anal light gray, narrowly edged with black. Caudal region marked by large oblong-ovate white area about as long as the length of head except snout, with three irregularly shaped small black blotches in it, a jet black blotch on the upper anterior border of white area and three similar, but smaller blotches on lower border. A large jet black blotch on anal fin under the middle part of white area.

Type is a male specimen, 206 mm in total length.

The measurements of another one male specimen, which is 118.5 mm in total length, are as follows: head 5.93 in total length; depth 11.50; distance from origin of ventral to anal 5.04. Eye 3.00 in head; snout 3.23; maxillary 3.00, interorbital space 3.64, post-orbital part of head 2.11; pectoral 1.67; ventral 5.0. In this specimen, the caudal white area is provided with only one small black spot in it.

The present species resembles an American species *Lycodes digitatus* Gill & Townsend in having a smaller number of rays of dorsal and anal, but differs from it in having the shorter head, larger eye and peculiar caudal marks.

Pyramodon ventralis SMITH & RADCLIFFE

Pyramodon ventralis Smith & Radcliffe, Proc. U. S. Nat. Mus., 44, 1913, p. 175, pl. 17, fig. 3 (Dutch East Indies.)

D. 125; A. 135; P. 26; branchiostegals 7.

Head 6.18 in total length; depth 7.28; distance from tip of snout to origin of anal 4.66; distance from tip of snout to origin of dorsal 5.01. Eye equal to snout, 4.89 in head; maxillary 1.87; interorbital space 4.61; post-orbital part of head 1.64; pectoral 0.90; width of pectoral at base 4.54; longest dorsal ray 3.49; longest anal ray 2.59; ventral 3.24; distance from origin of ventral to anal 1.53.

Body much elongate, compressed, the greatest depth behind vent and tapering posteriorly into pointed caudal; upper profile of head very slightly elevated from tip of snout to occipital region; ventral outline roundly convex from isthmus to below tip of pectoral.

Mouth large, oblique; premaxillary protractile; maxillary extending well beyond the orbit, its exposed surface shallowly channeled longitudinally; lower jaw somewhat shorter than upper when mouth is closed. Upper jaw with rather broad band of villiform teeth and bearing anteriorly a pair of depressible sharp canines on each side, the outer one much larger than inner one. Mandible with a pair of long fangs, directed obliquely backward, its length nearly equal to half the length of eye; on sides of mandible only a single series of small conical teeth present. Vomer with a long fang, somewhat longer than those of lower jaw, and several small villiform teeth. A single series of small conical teeth on the palatines.

Head entirely smooth; interorbital space

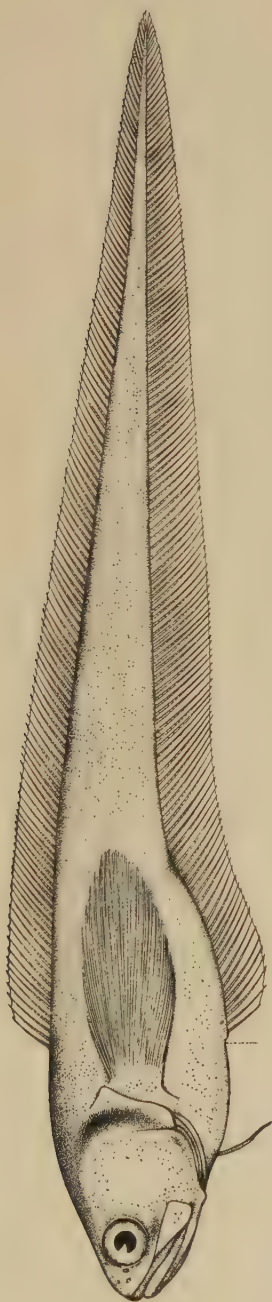


Fig. 2. *Pyramodon ventralis* Smith & Radcliffe $\times \frac{2}{3}$

very wide and roundly convex. Opercular spines absent. Preopercle free below and entire. Vent situated anteriorly, the distance from vent to vertical below posterior end of opercular flap 2.47 times in head.

Dorsal inserted slightly in advance of vent. Pectoral very narrow and long, longer than length of head. Ventrals close together, each of single soft filament much longer than diameter of eye.

Lateral line absent. Scales entirely absent; skin smooth, but not lax. Gill-membranes separated, free from the isthmus. Pseudobranchiae absent. Three slender gill-rakers on lower limb of first arch next to the angle, about equal to half the diameter of eye.

Color in formalin light gray, profusely scattered by small pigment spots. Mouth and gill-cavity blackish. Peritoneum jet black.

The above description based upon a male specimen 196.5 mm in total length.

The measurements of another male specimen, 186.0 mm long, are as follows: Head 6.02 in total length; depth 6.53; distance from tip of snout to origin of anal 4.55; distance from tip of snout to origin of dorsal 5.01. Eye 5.00 in head; snout 4.75; maxillary 2.03; interorbital space 4.54; postorbital part of head 1.63; pectoral 0.99; width of base of pectoral 4.54; ventral 3.86; distance from origin of ventral to anal 1.73.

Bears resemblance to Hawaiian species *Snyderidia canina* Gilbert especially in having long canines on jaws and vomer, but presents distinction from it in the following points: ventrals present; pseudobranchiae absent; body rather thickened anteriorly, head 6.02–6.18 in total length; depth 6.53–7.28; distance from tip of snout to origin of dorsal 5.00; pectoral very long and filamentous, longer than head; teeth of lower jaw in a single series.

The specimens under my examination agree well with the original description in important characters except the complete absence of pseudobranchiae which are "represented by 2 small filaments" in a single specimen of Smith and Radcliffe.

The genus *Pyramodon* which was put under Carapidae by Smith and Radcliffe is closely allied to the genus *Snyderidia* which was considered by Gilbert as a member of Lycodapidae. It may be mentioned that the two families in question are defined to differ essentially in the position of the vent, and in this character stand the two genera just intermediate between the two families. Thus, it seems advisable to emend Carapidae to include *Pyramodon* as well as *Snyderidia*.

Biometry of Two Species of Japanese Cardinal-fishes, with Special Reference to their Taxonomy.*

Kiyomatsu MATSUBARA

(Received March 15, 1936)

The group of cardinal-fishes comprises many forms which are placed in several families. Since the interrelationships of their families, genera, and species are very close, separation of one from any other is of no easy matter. Therefore, a thorough revision on the basis of biometry is much needed of this group, especially of deep-sea species which are mostly based on very few imperfect specimens.

Among the fishes obtained in January, 1936 off Owase, Mie-ken at a depth of about 170 fathoms, more than 30 specimens of cardinal-fishes belonging to Apogonidae were found. Of these 29 are referable to *Hynnodus atherinoides* Gilbert⁴⁾ and 5 to *Parahynnodus robustus* Barnard.¹⁾ Biometrical examination of the material at my disposal as well as scrutiny of the original descriptions of the above-mentioned two and other allied species have led the author to the conclusion that the genera *Hynnodus*, *Parahynnodus* and *Scepterias* should be united with the genus *Epigonus* which needs emendation for this union.

The present paper embodies (1) routine work of species description with a view to supplementing the one first published, (2) graphical representation of biometric data of my specimens, coupled with plotting of the measurements of the specimens of the same and allied species by previous authors, and (3) discussion on taxonomy of the genera and species.

It is with great pleasure that I take this opportunity of expressing my indebtedness to Prof. Arata Terao for his invaluable help given in the course of the present work. I wish to express my best thanks to Mr. Genkiti Abe, of Nisiura-mura, Hôigun, Aiti-ken for his kindness in supplying most of the specimens which I used in the present work, and also to Prof. Toshiharu Kamohara for ascertaining the absence of tooth in his specimens of *E. atherinoides* obtained in Kôti.

* Contributions from the Zoological Laboratory, Imperial Fisheries Institute, No. 58.

Epigonus RAFINESQUE, emend.

Epigonus RAFINESQUE, 1810, Indice d'Ittiologia Siciliana, p. 64.

Pomatonus RISSO, 1810, Ichthyologie de Nice, p. 301 (the name is preoccupied)

Hynnodus GILBERT, 1903 (1905), Bull. U. S. Fish. Comm. 23 (2), p. 617.

Scepterias JORDAN & JORDAN, 1922, Mem. Car. Mus. 10 (1), p. 44.

Parahynnodus BARNARD, 1927, Ann. South African Mus. 21 (2), p. 525.

Body slender or elongate, covered with rather large, deciduous scales. Head large, covered with scales. Eyes very large. Teeth villiform, if present, but sometimes entirely absent. Preoperculum with prominent rounded angle, without spine; operculum with one or rarely two feeble spines. Maxillary narrow, concealed beneath the narrow preorbital, except the posterior end. Dorsal fins well separated, first with 7 slender spines; anal with 2 spines; caudal emarginated or forked; the fins more or less scaly. Tubes of lateral line very large.

Epigonus atherinoides (GILBERT)

Hynnodus atherinoides GILBERT, 1903 (1905), p. 618, pl. 79 (Hawaii); FOWLER, 1928, p. 165 (Lahaina, Maui); FOWLER & BEAN, 1930, p. 121 (Philippines)

Hynnodus megalops SMITH & RADCLIFFE, 1921, p. 445 pl. 38, Fig. 3 (Philippines)

Scepterias fragilis JORDAN & JORDAN, 1922, p. 45, pl. 2 (Hawaii); KAMOHARA, 1936, p. 18 (Kôti).

D. VII-1, 10; A. II, 9; V. 1.5; p. 19; scales in the lateral line 45; gill-rakers on first arch 9+19; branchiostegals 6. Head 2.97 in body length; depth 5.05; eye 2.28 in head; snout 4.81; postorbital part of head 2.43; maxillary 2.31; interorbital space 3.52; distance from origin of ventral to anal 1.14; length of caudal peduncle 1.24; depth of same 3.25; pectoral 2.18; longest dorsal spine 2.31; spine of second dorsal 5.29; longest dorsal ray 2.34; second anal spine 5.29; longest anal ray 2.42; ventral spine 3.63; longest ventral ray 2.47.

Body elongate and soft; head large and flattish above, somewhat higher than wide; snout short and blunt; jaws equal; mouth oblique; maxillary rather wide, about twice as wide as the preorbital, partly slipping under it, scarcely reaches posteriorly to under middle of eye. Tooth entirely absent. Eye very large, slightly shorter than half the length of head. Nostrils very small, not raised, the anterior slit-like, the other a round pore. Preopercle entire, the angle roundly produced; a rudimentary opercular spine present, not projecting on the skin. Dorsal

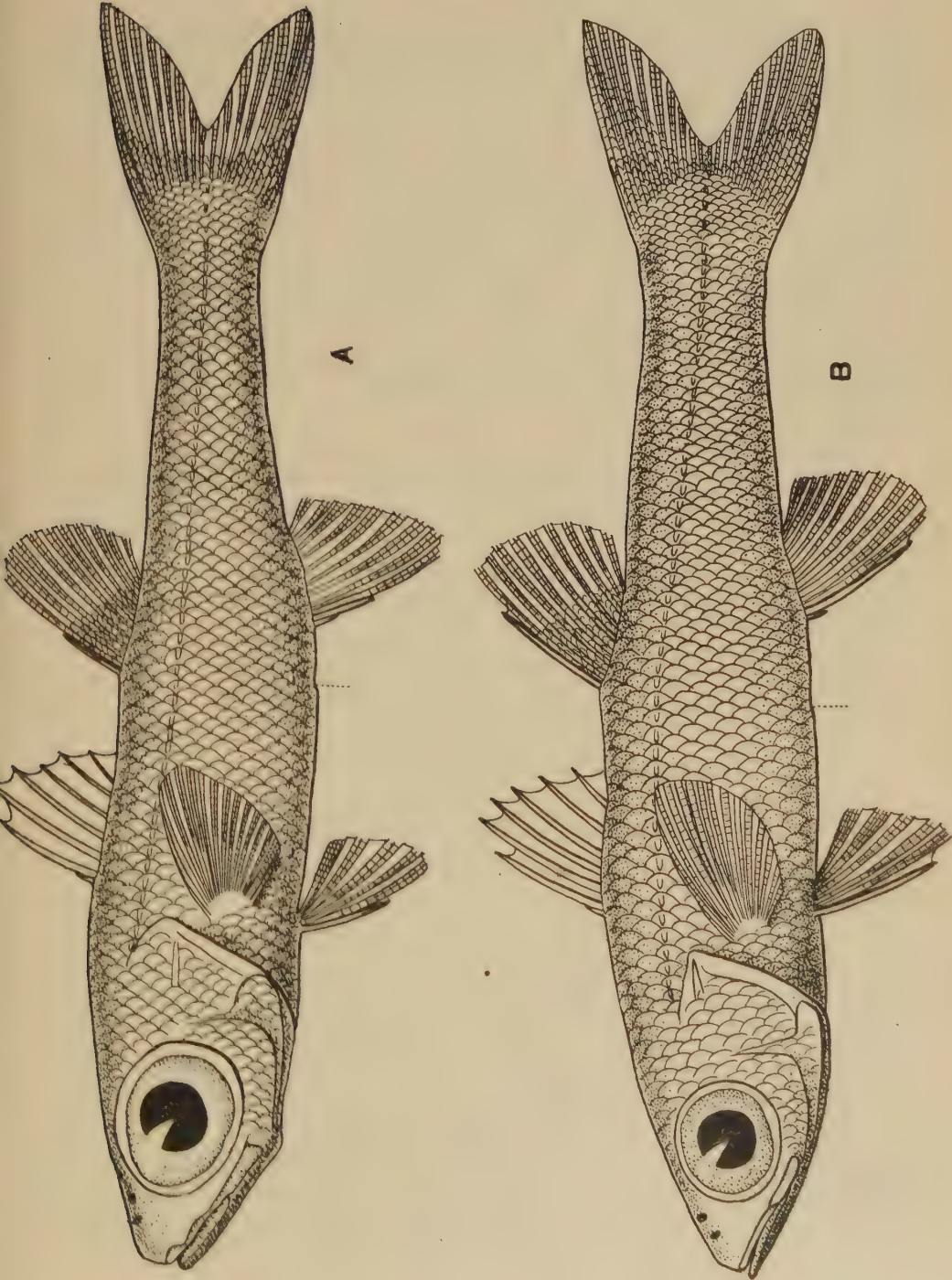


Fig. 1. A, *Epigonus altherioides* (Gilbert) $\times 1\frac{1}{2}$ B, *E. robustus* (Barnard) $\times 1\frac{1}{2}$

spines slender, the first one very small, somewhat shorter than one-fifth the length of third spine which is the longest; second dorsal very high, preceded by a small spine which is shorter than a half length of eye. Interspace between dorsals much shorter than one-third the head. Anal also high, provided with two small spines, the second one as long as the spine of second dorsal. Ventral inserted just below the anterior end of pectoral base; ventral spine somewhat longer than half the length of eye. Interspace between origin of ventral and anal equals to head without snout. Pectoral rather short, not extending to vent. Caudal deeply forked. Scales deciduous; tip of head, cheek, opercle, basal half of dorsal and caudal base also covered with smaller scales. Pseudobranchiae very large; gill-rakers long and slender, the longest 2.35 in eye.

Color grayish brown, paler below, without special marks.

The above description and figure are based on a male specimen, Imperial Fisheries Institute Fish-spec. No. 1782, measuring 135 mm in total length.

This specimen differs from the one described by Gilbert⁴⁾ in having deeper body, higher dorsal and anal and in lacking tooth, but agrees with it in other important characters. These discrepancies appear to be due to local or individual variations.

Habitat: Hawaii; Philippines; Oceania; Kôti; Owase.

Epigonus robustus (BARNARD)

Parahymnodus robustus BARNARD, 1927, p. 525 (Off Cape point, South Africa).

D. VII-1, 9; A. II, 9; V. I, 5; P. 15; scales in the lateral line 47; gill-rakers on first arch 8+18; branchiostegals 7. Head 3.27 in body length; depth 4.76. Eye 2.78 in head; snout 4.40; maxillary 2.49; interorbital space 3.81; postorbital part of head 2.51; distance from origin of ventral to anal 1.04; length of caudal peduncle 1.13; depth of same 2.63; pectoral 1.88; longest dorsal spine 2.11; spine of second dorsal 2.51; longest dorsal ray 1.74; second anal spine 2.40; longest anal ray 1.93; ventral spine 2.46; longest ventral ray 1.96.

Body elongate; head rather large, somewhat roundish above, much higher than wide; snout short and blunt; lower jaw slightly projects beyond the upper when mouth is closed; mouth oblique; maxillary very narrow, nearly as wide as the narrow preorbital, partly slipping under

it, and extending posteriorly to somewhat beyond the anterior end of pupil. Tooth entirely absent. Eye very large, but much smaller than half the length of head. Nostrils small, not raised, the posterior one

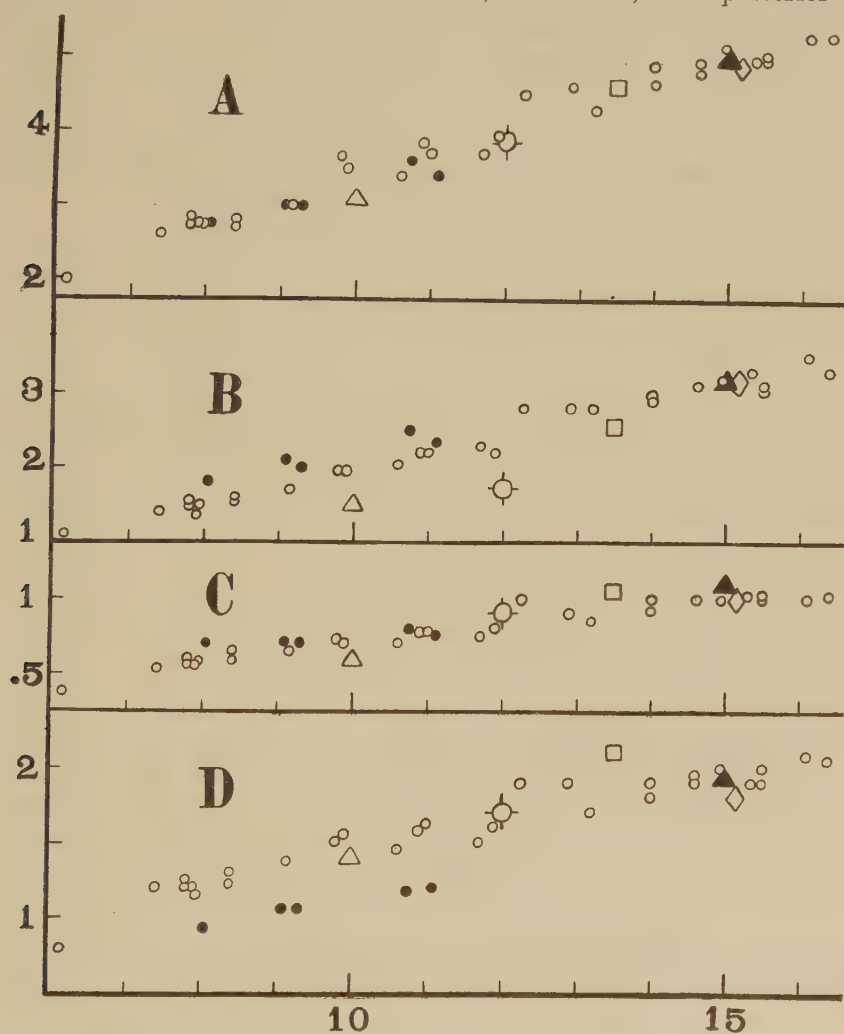


Fig. 2. Showing dimension (in cm) of body parts in relation to body length of *Epigonus atherinoides*, *Epigonus robustus* and also the corresponding data of the original descriptions of species which should be included in the genus *Epigonus*.

A, length of head; B, depth of body; C, length of snout; D, diameter of orbit.

○, *E. atherinoides*; ●, *E. robustus*; △, *Hymnodus atherinoides* of Gilbert; □, *H. megalops* of Smith & Radcliffe; ◇, *Scepterias fragilis* of Jordan & Jordan; ⊙, *Epigonus occidentalis* of Goode & Bean; ▲, *Parahymnodus robustus* of Barnard.

circular, anterior one slit-like, directed forward. Preopercle entire, its posterior angle bluntly produced. Opercle ends in a pungent spine.

Dorsal spine slender, the first one rudimentary, the third one the longest, a little shorter than half the head. The second dorsal and anal high; the spine of second dorsal and second anal spine very long, each longer than diameter of eye. Distance between dorsals shorter than one-third the head. Ventral inserted a little posterior to the hind end of pectoral base; ventral spine very long, longer than eye. Pectoral as long as ventral, longer than half the length of head. Distance between origin of ventral and anal subequal to head length.

Scales not so deciduous; head entirely scaly except snout, sub-orbital and jaws; basal half of second dorsal and caudal also thickly covered with small scales.

Color dark brown, a little paler below; no special markings. Described from a male specimen, Imperial Fisheries Institute Fish Spec. No. 1776, measuring 135 mm in total length.

Barnard's original description¹⁾ stands at variance with my material in having somewhat larger eye, but quite tallies with it in other important characters.

Habitat: South Africa; Owase.

Remarks on the graphs.

As already mentioned, dimensions of various parts of body of my specimens are plotted in Figs. 2~6 against their body length. In these figures are also given the corresponding data of the specimens which were chosen by previous authors as types of *Epigonus occidentalis*, *Hynnodus atherinoides*, *H. megalops*, *Scepterias fragilis*, and *Parahynnodus robustus* respectively. In other words, these 5 figures sum up all the available data concerning the species under consideration, so that they will warrant us to decide conclusively whether or not the material at my disposal can be identified with any of the species, and also whether or not one species can be synonymized with any other.

1. First, I shall confine myself to the data of my specimens. They are represented in the figures by circles, white one indicating the material referable to *E. atherinoides* and black one showing the one referable to *E. robustus*. It is to be seen in the illustrations that the material represents two species so far as the data of the diameter of

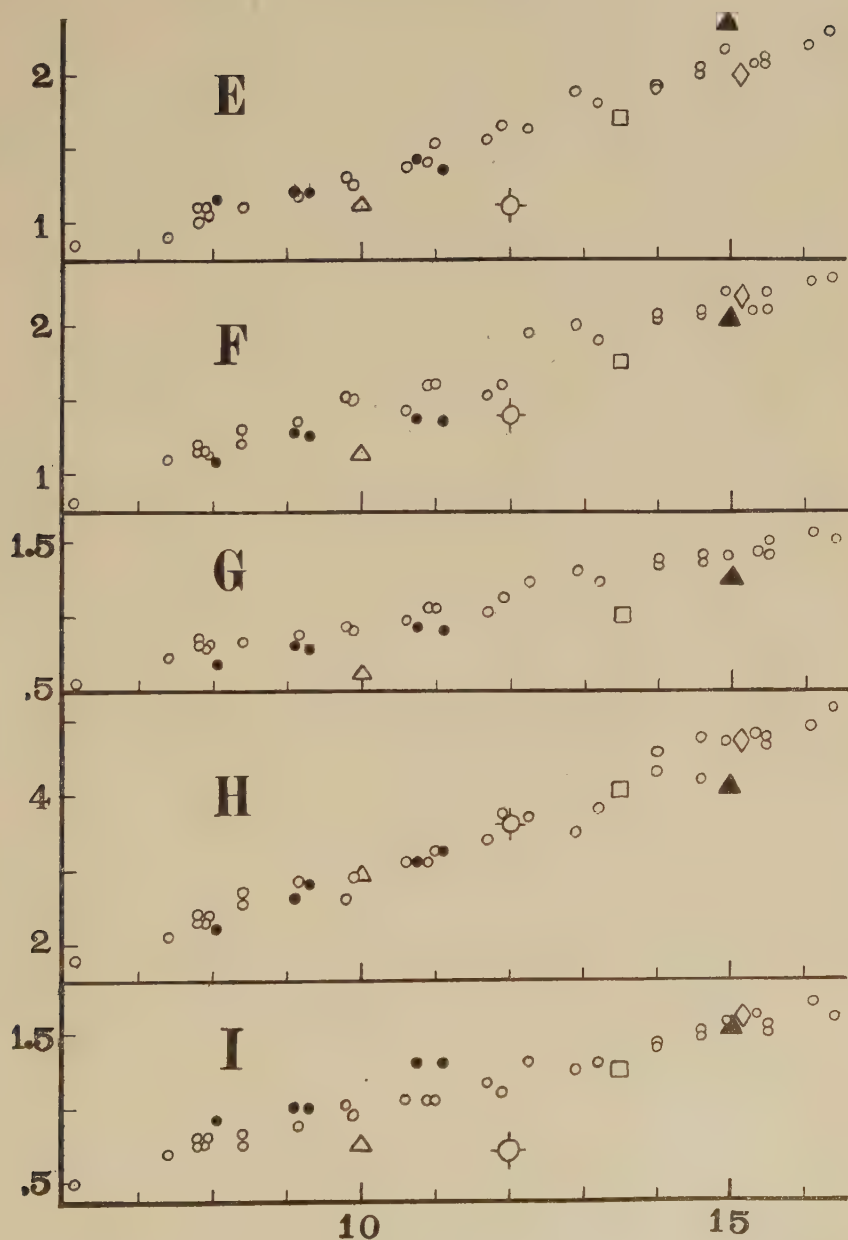


Fig. 3. Same as in Fig. 2 with same specific symbols. E, length of postorbital part of head; F, length of maxillary; G, width of Interorbital space; H, Distance from origin of ventral to anal; I, depth of caudal peduncle.

the eye, length of ventral spine, length of second anal spine and length of spine of second dorsal fin go.

The particulars of the respective items are as follows:

- a. **Diameter of eye:** As clearly shown in Fig. 2, D., there is a rather distinct difference between the two species in the relative diameter of eye against the body length. The ratio of the diameter of eye to the head length becomes greater as the length of body increases in both species, but the value varies 2.08~2.66 in *atherinoides* and 2.78~3.03 in *robustus*.
- b. **Length of ventral spine:** In the relative length of ventral spine to body length, almost the same degree of difference can be seen between the two species as is the case with diameter of eye to the body length (Fig. 4, L.). The ratio of the length of ventral spine to head length also increases as the body length increases nearly at the same rate as in the ratio of diameter of eye to head length, viz. 3.32~4.76 in *atherinoides* and 2.46~2.81 in *robustus*.
- c. **Length of second anal spine:** There is a marked difference between the two species in the length of second anal spine when related to body length (Fig. 5, P.). This difference is much greater than the two items noted above. The ratio of length of second anal spine to head length differs greatly in the two species, namely, 4.44~5.47 in *atherinoides*, whilst 2.51~2.75 in *robustus*.
- d. **Length of spine of second dorsal fin:** In the correlation of the length of spine of second dorsal fin to body length, almost the same degree of difference can be seen in the two species, as is the case with the length of second anal spine to the body length (Fig. 5, O.), and the ratio of the length of spine of second dorsal fin to body length is 4.75~6.79 in *atherinoides* and 2.51~2.75 in latter species.

2. The previous authors' data of all the species noted above and indicated in Figs. 2 to 6 show that *Epigonus occidentalis* appears to be essentially a distinct species from any other and *Parahynnodus robustus* and *Hynnodus atherinoides* may be clearly distinguished from each other. Both *Hynnodus megalops* and *Scepterias fragilis* do not stand apart from *H. atherinoides* and should be synonymized with it. Although dorsal fin and anal fin of *H. atherinoides* are remarkably low, these may be

due to the damage as Fowler and Bean³⁾ pointed out. There is no room for doubt that *Epigonus telescopus* can be distinguished from any of the species noted above by various points such as lateral line scales numbering 40 and the depth of the body corresponding to nearly one-fourth of the entire length of the body.

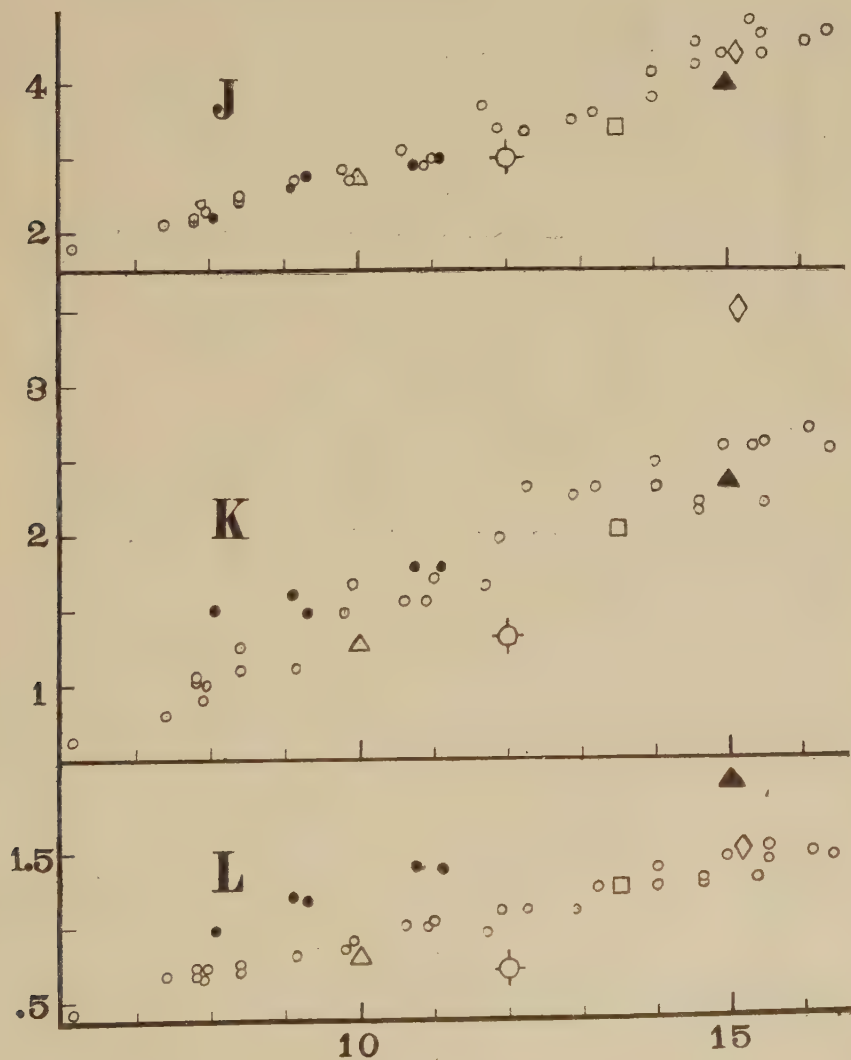


Fig. 4. Same as in Figs. 2 and 3 with same specific symbols. J, length of caudal peduncle; K, length of pectoral; L, length of ventral spine.

Discussion

Four genera, *Epigonus* Rafinesque 1810, *Hynnodus* Gilbert 1905, *Scepterias* Jordan & Jordan 1922 and *Parahynnodus* Barnard 1927 are all

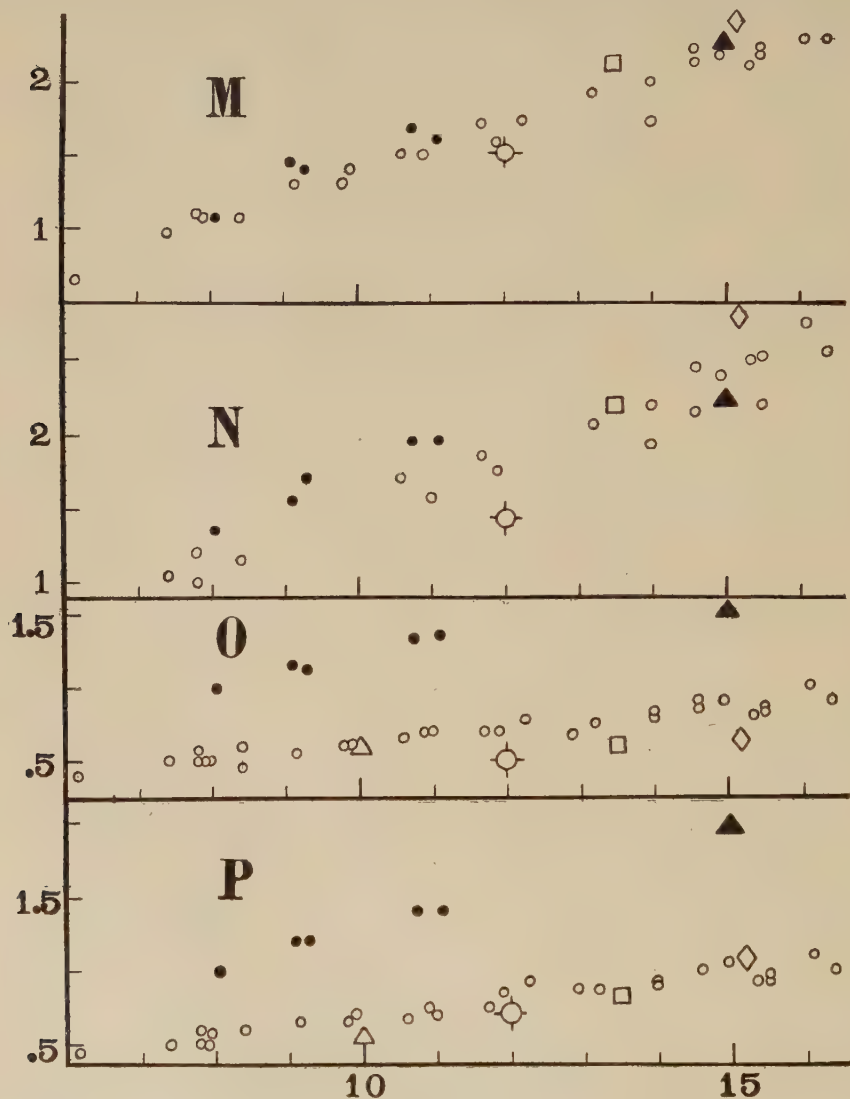


Fig. 5 Some as in Figs 2—4, with same specific symbols. M, length of longest dorsal spine; N, length of longest dorsal ray; O, length of spine of second dorsal fin; P length of second anal spine.

very much alike. As already noted, they are defined to be distinguished from each other principally by the presence or absence of teeth, depth of body and heights of dorsal fin and anal fin as well as by the number of opercular spine, other characters being similar. *Epigonus* possesses two opercular spines and small villiform teeth, usually on both jaws only, and these were regarded as important points of difference from three other genera. But *Epigonus occidentalis* Goode & Bean⁵ has one opercular spine. *Hymnodus* has somewhat slender body, very small teeth on both jaws, vomer and palatines, and rather low dorsal and anal fins, all these being regarded as generic characters. *Sceptrais* has small teeth on both jaws and vomer only; body is somewhat deeper

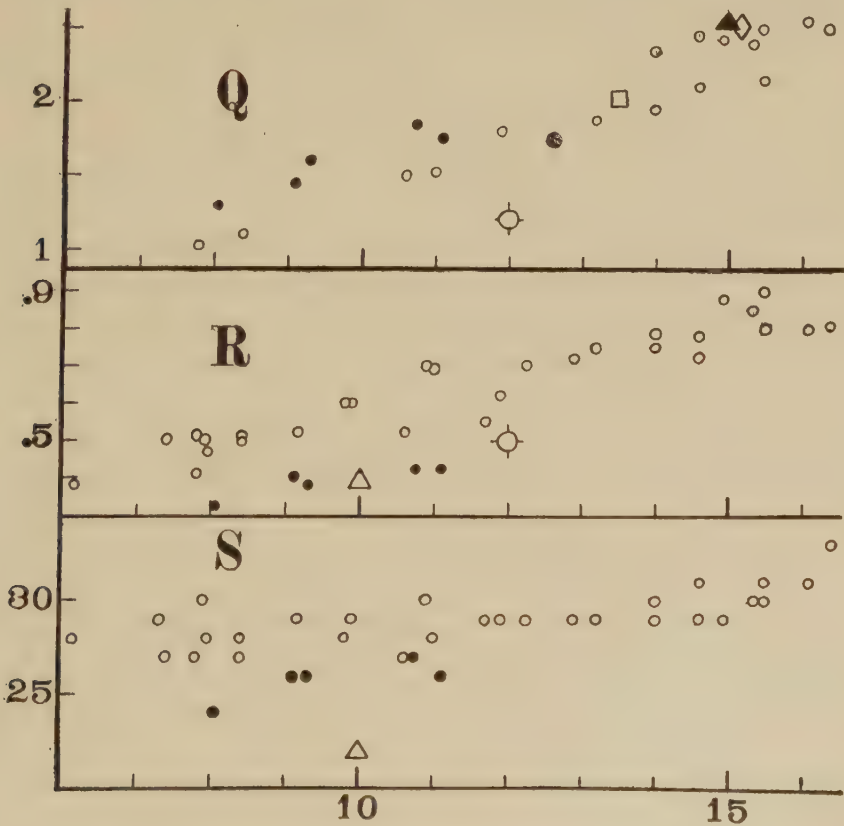


Fig. 6 Same as in Figs 2—5, with same specific symbols. Q, length of longest anal ray; R, length of longest gill-raker; S, Number of gill-raker on first arch.

and fins are higher than the former. Again, the form of body and the height of fins of *Parahynnodus* are almost the same as in *Hynnodus*, but the tooth is entirely absent. It may be mentioned that 29 specimens taken by me and referable to *Hynnodus atherinoides* and the specimens of the same species, which were procured by Prof. Toshiharu Kamohara off the coast of Kôti have no tooth in contradiction to the original description of the species. In other words, the presence or absence of the teeth was regarded as an important character to distinguish these four genera, but it is too trifle and unstable in nature as a generic criterion. It appears to me better therefore to emend the character of *Epigonus* and include three other genera in it. To sum up, the six species described under the four genera noted above should go as four species of one and the same genus.

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Larvae and Young of Fishes found in the Vicinity of Kominato, II—VI.*

Syûya NAKAMURA.

(Received Sep. 1, 1935).

II. *Atherion elymus* Jordan & Starks.

The present species is a member of Atherinonidae and widely distributed along the coasts of Japan. This fish is not consumed as food for man but is utilized as bait for fishing the bonito in case the sardine (*Englauris*) is not available.

The young stages of this species were dwelt on by Uchida,⁷ and touched on by Nakamura⁶; but nothing is known of the embryos and early larval stages of this fish. In the following paragraphs are given habit, embryonic development, and changes which take place in the proportion of various parts of body as the fish grows older.

Habit. *Atherion elymus* Jordan and Starks and its allied species, *Atherina bleekeri* Günther and *Atherina tsurugae* Jordan & Starks, inhabit the littoral zone of Kominato and among these three *Atherion elymus* comes nearest to the shore, frequenting the tide pools on rocks of it.

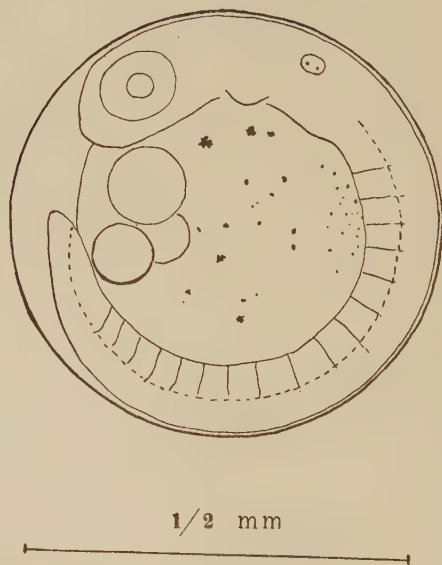
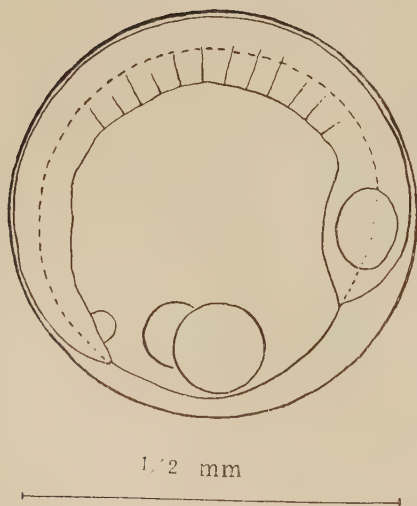
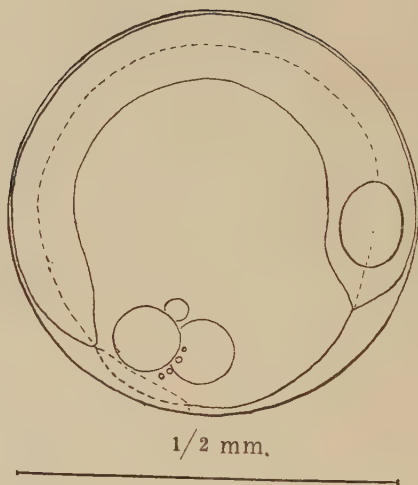
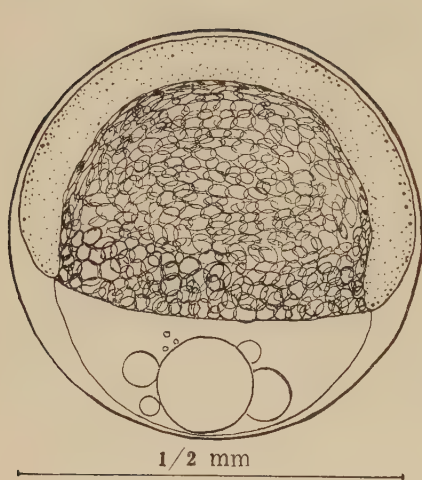
The contents of alimentary canal show that they feed mostly on zooplankton but they eat a great quantity of diatoms in winter. It should be mentioned that insects were found in the alimentary canal of the fish caught in May.

The spawning season lasts from June to September in the neighbourhood of Kominato.

Embryonic stage. I obtained an egg-mass attached to *Sargassum* growing near sea-shore on June 30th, 1933, and I also succeeded to make the fish spawn in the aquarium on July 2nd, 1933. The egg-mass is as large as the distal half of the thumb of a man.

The egg measures 0.55 to 0.58 mm. in diameter, with several larger and smaller oil-globules, the largest of which is 0.16 mm. in diameter.

* Contributions from the Zoological Laboratory, Imperial Fisheries Institute, Tokyo (No. 59), and from the Kominato Marine Biological Laboratory, Prov. Bôsyû (No. 2).



Figs. 1~4.

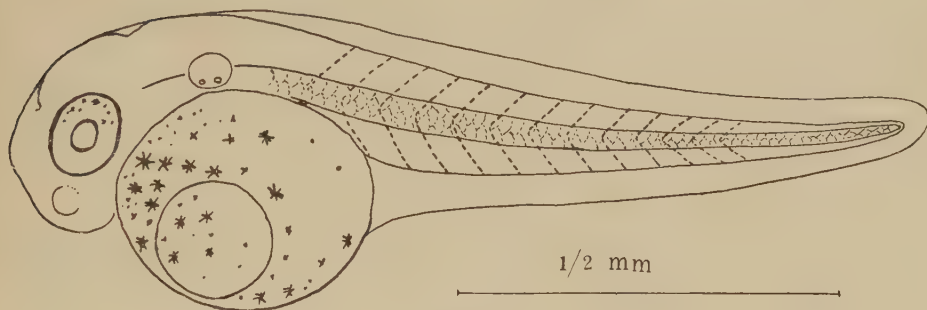


Fig. 5.

The yolk is tinged with greenish yellow and somewhat transparent.

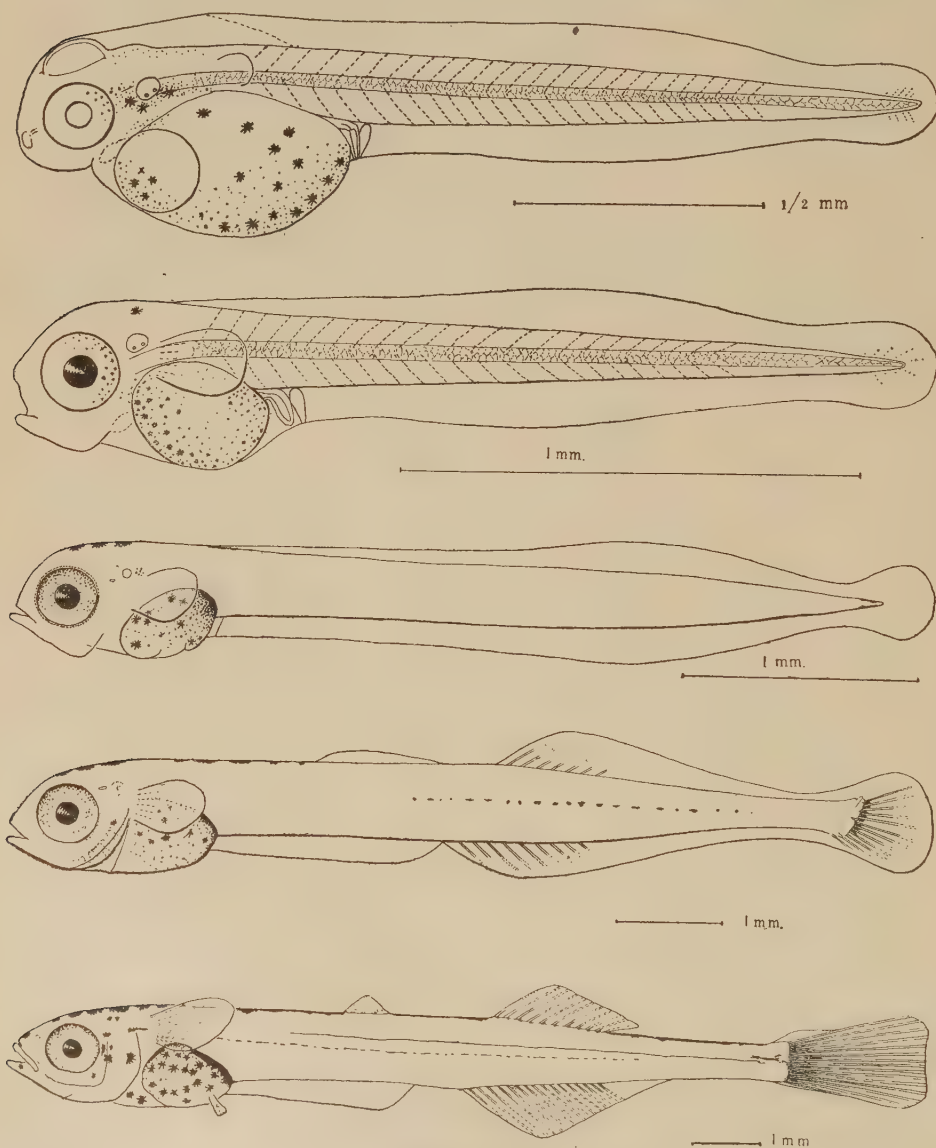
The temperature and specific gravity of the medium in which the developing eggs were kept remained almost constant as shown in the following table.

Day	Time	Water temp. (°C)	Spec. grav. (at 15°C)	Developmental stage
2/VII	2 p.m.	23.1	1.02551	
	3 p.m.			blastoderm covers the half of the globe.
	6 p.m.	23.0	1.02525	
	11 p.m.			the same covers three fourth of the globe (Fig. 1).
3/VII	5 a.m.			body is outlined.
	6 a.m.	23.1	1.02535	... optic vesicle arises (Fig. 2).
	9 a.m.			myotomes begin to appear
	10 a.m.	23.2	1.02527	
	10.30 a.m.			Kupfer's vesicle appears (Fig. 3).
	2 p.m.	23.0	1.02542	
	6 p.m.	23.0	1.02542	... body begins to make sluggish movement (Fig. 4).
4/VII	6 a.m.	23.0	1.02539	
	10 a.m.	22.5	1.02539	
	2 p.m.	22.5	1.02532	
	6 p.m.	22.5	1.02542	... some hatch from the egg.

Larval and young stages. A newly hatched larva as shown in Fig. 5 measures 1.1 to 1.2 mm long and the trunk which is not yet straight is provided with about 44 pairs of myotomes. The yolk-sac

about 0.35 mm along the long axis, and contains one or few oil globules near its middle.

The otocysts are situated above the middle of yolk-sac. Stellate black pigment cells are present on the yolk-sac, black and yellow pig-



Figs. 6~10.

ment on optic cup, and several yellow pigments on the middle of anal fin fold.

Twelve hours after hatching the larva attains to 1.85 mm in length (Fig. 6). The trunk is now straight; otocysts have moved forward towards the eyes; anlagen of pectoral fins are laid down above the middle of yolk-sac; hind gut and air bladder are visible; oil globule is at the anterior end of yolk-sac; black and yellow pigments are present near the middle of the anal fin fold.

A larva a day and half old is only 2.0 mm long, but its organisation is much more advanced (Fig. 7). The oil globule disappears within the ever smaller yolk-sac. Otocysts have shifted to just behind the eye; mouth is formed but not yet movable and anus is still closed. The eye is deeply blue and lustrous; a black stellate pigment is present above otocyst and a few black and yellow pigments on the yolk-sac.

The observations given above were made on living specimens cultured in aquarium. Unfortunately they were found dead soon after that.

The smallest post-larva which was obtained by surface-tow from sea measured 3.7 mm long. Fig. 8 shows a larva 3.8 mm in length. Its body is very elongate, and the anus is situated far forward so that preanal is $\frac{1}{5}$ the total length; the unpaired finfold is widest at two-thirds from anterior edge of fin; the axial skeleton is straight; stellate black pigments are found above and below the posterior extremity of the axial skeleton, and the same sort of pigment is seen on eye-capsule and on peritoneum as well.

At a stage with a length of 7.4 mm, the axial skeleton is still straight, but the hypural bone is laid down and the rays are seen radiating from it; anterior portion of dorsal fin fold begins to disappear; behind the three pigments on the head are now seen a few pigments; several black pigments appear along lateral median line and on caudal base; the pigments which were formed above and below the axial skeleton are still present in many specimens but already absent in some.

In a specimen 8.7 mm long (Fig. 9), the posterior extremity of the axial skeleton is now curved upwards; a varying number of rays of dorsal and anal begin to appear but without any segmentation; the fin fold is reduced in extent, remaining at the insertion of first dorsal, in the intermediate area between anus and anal fin, and also on upper

and lower sides of caudal peduncle; each pigment line on anterior dorsal and on a lateral median line is more developed.

A post larva which has grown up to 11 mm. length has incipient dorsal spines; the fin fold is seen remaining in post-anal region; ventral fins have already begun to form at a stage having 10.3 mm. length; dorsal and lateral linear pigmentations are now much more developed.

At 13.4 mm stage (Fig. 10) the larva is provided with the definite number of the fin rays. There are 5 spines in 1st dorsal, 1 spine and 10 rays in second dorsal, and 1 spine and 16 rays in anal; no segmentation of fin rays is still observable; fin fold does not stretch to anal; preanal is $2.9/10$ the body length (11.5 mm.); black pigments profusely overlay dorsal median line from the crown of head to caudal peduncle with exceptions where the fins are situated, and on lateral side the dotted line is running from above the breast to above the extremity of anal; another line runs a little above the afore-mentioned line and before inferior part of 1st dorsal extending to caudal peduncle; besides, the pigments increase on opercle and abdomen and a pigment appears on each side of lower jaw near the tip.

In a specimen 15.6 mm. long, segmentation appears only in caudal fin ray, fin fold remains as before; pectoral reaches slightly beyond the anus; preanal is equal to $4.2/10$ of body length (13.1 mm.); there is none of the black pigment on ventral side which is silvery in lustre; a linear series of black pigments is found running along anterior half of base of anal; when the fish attains a length of 17.6 mm. (Fig. 11), the narrow fin fold is seen just behind the anus which has shifted just under the extremity of the pectoral so that preanal is half the body length (15.0 mm.); segmentation is present in caudal and anal fin rays and it also begins to appear in 2nd dorsal; minute spines are on the surface of lower jaw; cheek and ventral part silvery; a short line of black pigment runs along ventral median line of caudal peduncle.

The fin fold entirely disappears at the time the fish attains about 20 mm. in total length. In a specimen 25.0 mm. in total (Fig. 12); the preanal equals to about $5.5/10$ of body length (21.0 mm.); the scales already begin to form below the lateral line and there are membraneous scales with black pigments from above extremity of pectoral to caudal peduncle; a short black line runs along median line of caudal peduncle; minute spines increase in number on lower and



Figs. 11~13.

upper jaws, margin of preopercle, and upper border of orbital and on the frontal; 4 pores are found near the eye; beautiful greenish silvery zone runs backwards from the base of the pectoral (this part changes to greenish indigo in colour in adult); under this zone the body is silvery; still further below no pigment exists and is transparent.

The body of a 29.0 mm. long specimen as shown in Fig. 13 is nearly the same as the adult in many characters; the anus comes just before the anal, and the preanal corresponding to 5.9/10 of body length (25.0 mm.); the characteristic black line on the back extends anteriorly to above base of pectoral; greenish indigo zone runs longitudinally from base of pectoral to caudal peduncle, and under this line the body

is mostly silvery but almost near and behind the base of anal.

In a fish a little larger than this, greenish indigo line becomes dark greenish and the body is uniformly silvery below that.

As the spawning period extends from June to September, a shoal of this fish is very variable in its composition; sometimes it consists of mostly larger, sometimes smaller, and sometimes all mixed up.

Those of 40 to 60 mm. length appearing in June are no more than the young approaching the end of their first year, so that the sexual maturity is reached in the fish at one year old.

The fish attains to about 35.0 mm. until November and after that it scarcely reaches to 40 to 45 mm. length until next April, and it measures 40~60 mm. in June when the fish is sexually mature. The fish grows over 65 mm. until October.

Comparison. Fertilized eggs of this and other atherinoid fishes which inhabit the Japanese waters, have not yet been described. The egg of European species *Atherina Boyeri* Risso measures 3.25^d to 3.50 in diameter and that of *Atherina hepsetus* Linn. is 2.50 mm., far larger than that of *Atherion elymus* Jordan & Starks. These two species and *Atherina presbyter* Linn. have adhesive filaments on the surface of the egg, but

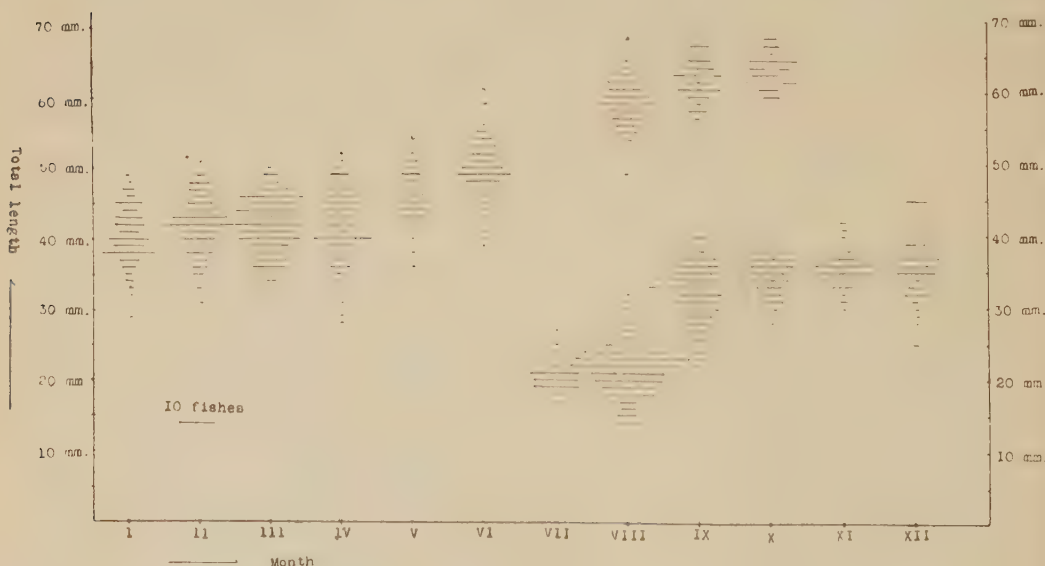


Fig. 14.

Atherion elymus Jordan & Starks is not provided with any such distinct filaments although the egg is very sticky.

Clark¹⁾ reports on growth of *Atherinopsis californiensis*, and asserts that the scales were not satisfactory for use in the age determinations since at least 30 per cent. of the individuals did not form an annulus during first winter, so he measured the body length. This fish does not mature before reaching 14 cm. in length and an age of two years, while older fishes attain to 33.4 cm. But sexual maturity is reached in *Atherion elymus* Jordan & Starks at one year old.

There are many similarities in the post-larvae of atherinoid fishes. The median fin fold of early post-larva is most widely spread behind middle part. Hand in hand with the reduction of fin fold, the rays begin to radiate in second dorsal and anal. Then anteriorly a part of fin fold feebly remains where the first dorsal should soon arise. A part of fin fold which is situated just behind anus disappears lastly. It is of common occurrence in these fishes that the anus shifts backwards with growth.

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III. *Chasmichthys dolichognathus* (Hilgendorf)

Habit. This fish inhabits rocky or sandy shores of Japan proper.

The spawning season of this fish in the vicinity of Kominato extends from January to May. In this season, we can often find a one-layered ellipsoid mass of eggs containing beautifully yellow spherical yolk adherent on the under-surface of stones near the sea-shore.

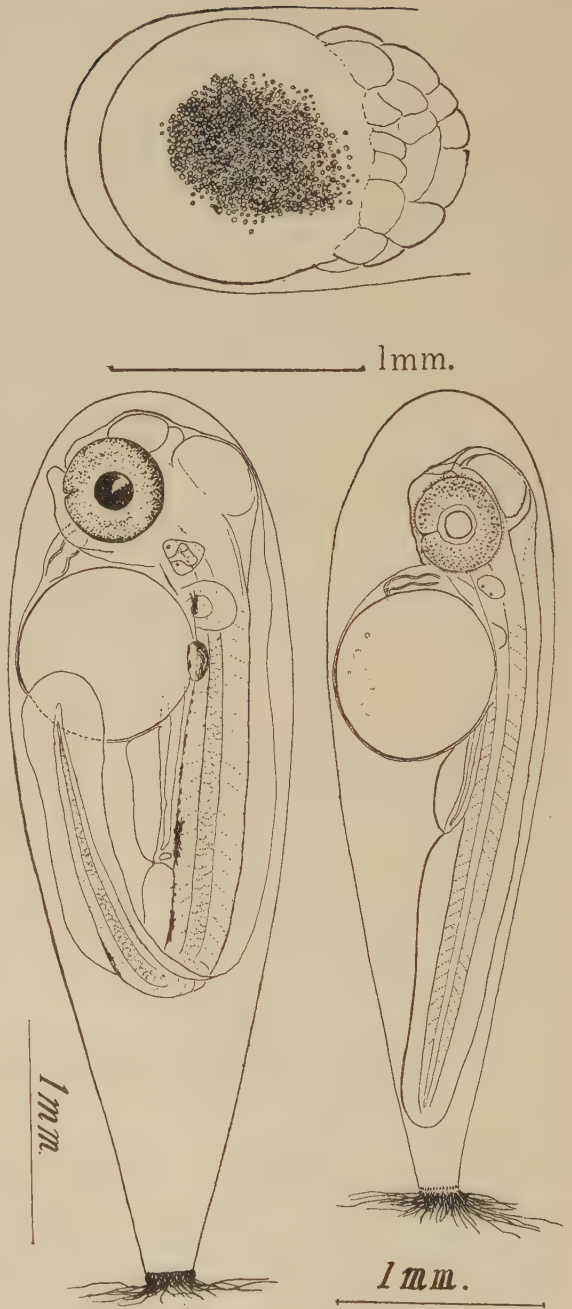
Embryo. The ripe ovarian ova are found near the outer sides of

the ovaries and each is already enclosed in the thin chorion with the adhesive filaments at one end.

The spawned egg is an elongated spindle in form. The narrow end, on which the egg rests, tapers gradually to a small facet or vesicle for attachment. The egg varies from 3.8 mm. to 4.5 mm. in length, and 1.10 mm. to 1.3 mm. in width, but each one in one egg mass is nearly the same in size. The number of eggs of a certain mass which was 47 mm. $\times$ 41 mm. in diameter, was about 450. The size of the egg-mass varies from 59 mm. $\times$ 50 mm. to 42 mm. $\times$ 30 mm.

Beneath the thick chorion the yolk is seen yellow in colour and its diameter is about 1.0 mm. $\sim$ 1.1 mm. in the earlier stages, so that the perivitelline space is very large. The numerous small oil globules exist at the vegetal pole of the egg. The early stage is shown in Fig. 1.

In an embryo with total length 3.3 mm. (Fig. 2) the brain is now dif-

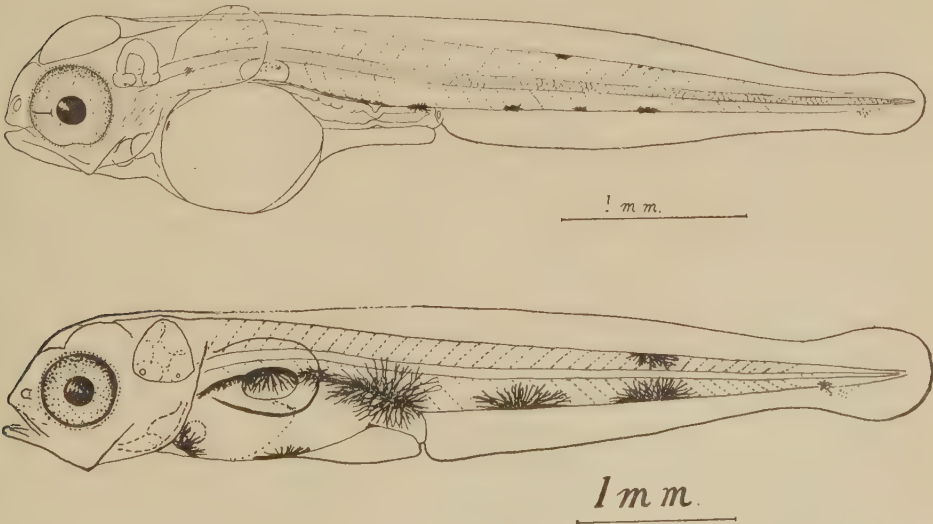


Figs. 1~3.

ferentiated, the otoliths have appeared in the otocysts, the eyes are almost completed but there is trace of flection in the inferior part, the heart is formed, the rudiments of pectoral fins are outlined and delicate protoplasmic strands stretch out from the body, the anus is not open, the number of myotomes is about 38 pairs. Black pigments begin to appear on the iris, the yellow pigments are scattered on the mid-brain and anterior part of the back.

At the time the embryo attains a length of about 4.0 mm. it stretches to the full length of the egg sac. Pectoral is slightly enlarged; black pigments on the eye are much denser. Black chromatophores begin to appear below the body from above of yolk to slightly posterior of anus. Yellow pigments on the back are now more obvious.

The embryos about 5.0 mm. long have their tails flexed (Fig. 3), and one of them is taken out of the sac and shown in Fig. 4; the pectoral fin is well defined and fan-shaped; mouth is complete; the auricle has shifted upward; and the blood stream is seen through the heart; the air-bladder is situated above the yolk; eye balls are black. Black chromatophores extend along the ventral edge of pre-anal region, and three black pigments are arranged at equal intervals along the same side of post-anal region. There are one or two small black chromatophores on the dorsal in the middle part of the tail, and other black



Figs. 4~5.



Figs. 6~7.

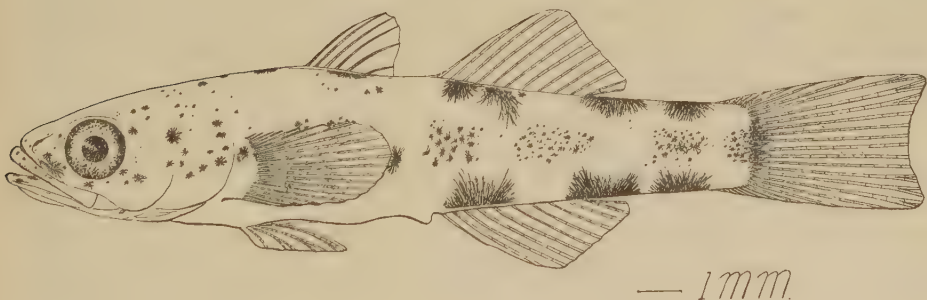
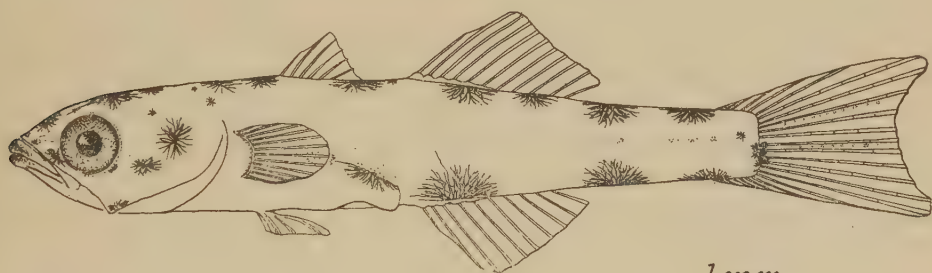
chromatophores at the base of pectorals, above the air bladder, and near the caudal edge.

Swimming stage. A 5.8 mm. larva (Fig. 5) presents more advanced characters than those of the previous stages, although the body is not so much elongated. This larva has already absorbed most of the yolk. The mouth is movable; the anus is opened. Tuberculous cells are arranged in a line and each is furnished with a flagellum. This series of cells forms the lateral line. The black pigments are seen along the roof of visceral cavity, and on the roof of intestine; there are 6 root-like black chromatophores on body: two on the ventral side, two on the ventral side of tail and posterior one of the two is opposite to 5th dorsal one, and 6th at point where base of hypural bone is to be formed. Lustrous yellow root-like pigments are seen on the mid-brain. When the embryo attains this size, it comes out of the sac with the aid of water-current, or by twisting the tails to break it. By this time they absorb the yolk almost completely. But occasionally they break out the membrane at an earlier larval stage.

In a post-larva 7.1 mm. in length (Fig. 6), the anterior dorsal larval fin disappears and the true rays begin to arise in 2nd dorsal, anal and caudal fins. The upward bending of axial skeleton near its end is

evident, true rays from the hypural bones are now visible. The mouth becomes similar to that of the adult fish. The speckles remain as they were.

Fig. 7 represents a young fish 12.5 mm. long which has lost most of larval fin with the exception of pre-anal one, and has 1st dorsal fin beginning to appear, but 2nd dorsal, anal and caudal fins are completely formed, although the margin of the caudal stay is concave. The granulated cells of the lateral line are arranged in two rows on the



Figs. 8~10.

caudal. Between the bases of 4th and 6th rays of 2nd dorsal there appear two root-like melanophores which are set opposite to lower melanophores, a melanophore at the end of 1st dorsal, and many on the head. Caudal melanophore stretches out to the membrane. In the young of 16.0 mm. length (Fig. 8), 1st dorsal fin is now complete, but the caudal margin is still concave. Melanophores appear on the upper and lower sides of caudal peduncle just in the middle and in front of caudal fin, and at the base between 8th and 10th rays of 2nd dorsal. The melanophores on the head and in front of 1st dorsal increase in number.

In a young fish 20.5 mm. (Fig. 9), the pectoral is much elongated and upper several rays begin to separate from each other. The pigments have increased in number and their colour is brownish. But smaller individuals as shown in Fig. 10 measuring 17.5 mm. in length often have their pectoral fin rays completely formed, and have only a few large isolated pigments on the body but 7-8 cross bands soon change to an irregular vermiculated pattern.

Crawling stage. Those which are more advanced than the above mentioned stage move about in a manner of crawling on the sea-bottom. At this stage, eye slightly approaches upward, and margin of tail becomes round. Characteristic patterns are formed on the dorsal, pectoral and caudal, and thus their external features are the same as those of adult. The maturity is reached in a year.

IV. *Chasmichthys gulosus* (Guichenot).

Habit. The distribution and habitat of this fish are the same as those of *C. dolichognathus*, although the fry and young fish of *C. dolichognathus* live even in the barren shallow tide-pool whereas the fry and young of *C. gulosus* live in the algal zone at a depth of about 1-2 meters, sometimes swimming freely in water and sometimes crawling on the bottom.

Food habit is also the same as that of *C. dolichognathus*, namely, the newly hatched-out post-larvae prey on copepods but they become omnivorous when their habit changes from swimming to crawling.

Embryo. The eggs are similar to those of *C. dolichognathus* and are attached to inferior surface of stones and rocks. The long axis of the egg is 3.8 mm.—4.5 mm. and the short axis is 1.05 mm.—1.40 mm. The size of egg mass ranges from 72 cm. × 79 cm. to 112 cm. × 158 cm. as far as my measurements go. The yolk is yellowish and contains in it

numerous oil globules which are somewhat larger than those of *C. dolichognathus*.

An embryo 1.95 mm. long (Fig. 11) has its tail separated from the surface of the yolk, its eye well formed, and myotomes 19 pairs in number. The yolk-sac is large and 1.35 mm. in diameter.

When the embryo attains to a length of 4.3 mm.

(Fig. 12), its brain, heart, intestine and rudiment of pectoral fin are formed. The oil globules are fused into a large one. Melanophores occur on the eye, on the mid-brain, on the dorsal and ventral borders and on the yolk-sac.

The embryo of 5.6 mm. length (Fig. 13) is much more characterized. The pectoral fin is enlarged and fan-shaped; the mouth is complete, the auricle removed upward; air bladder is formed; 8 melanophores are arranged in a file on the dorsal median from head to tail, and other black pigments exist on the air bladder, roof of intestine, and two pigments in the postanal region. These peculiar arrangement of melanophores is already evident when the embryo is 4.6 mm. long. Yellow pigments exist on the back, and the more anterior the denser they are.

Swimming stage. When the embryo attains to lengths of 5.5 mm. to 6.1 mm. it gets free out of the membrane by the same manner as that of *C. dolichognathus*. Just hatched larva sometimes still has a small quantity of the yolk but it feeds on copepods as soon as it completely absorbs the yolk.

In the post-larva of 6.7 mm. length (Fig. 14), the diminished yolk seems to consist almost entirely of small oil globules. The posterior otolith in the otocyst becomes larger than the anterior one. Lateral line now consists of flagellated protuberant cells which are arranged on the opercular margin and on the lateral side of body. The characteristic melanophore appears near the caudal end. Yellow pigments are well

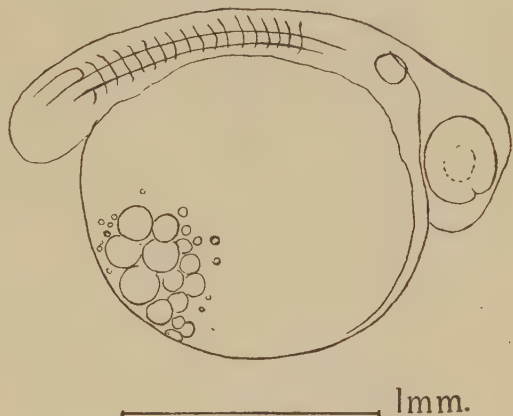
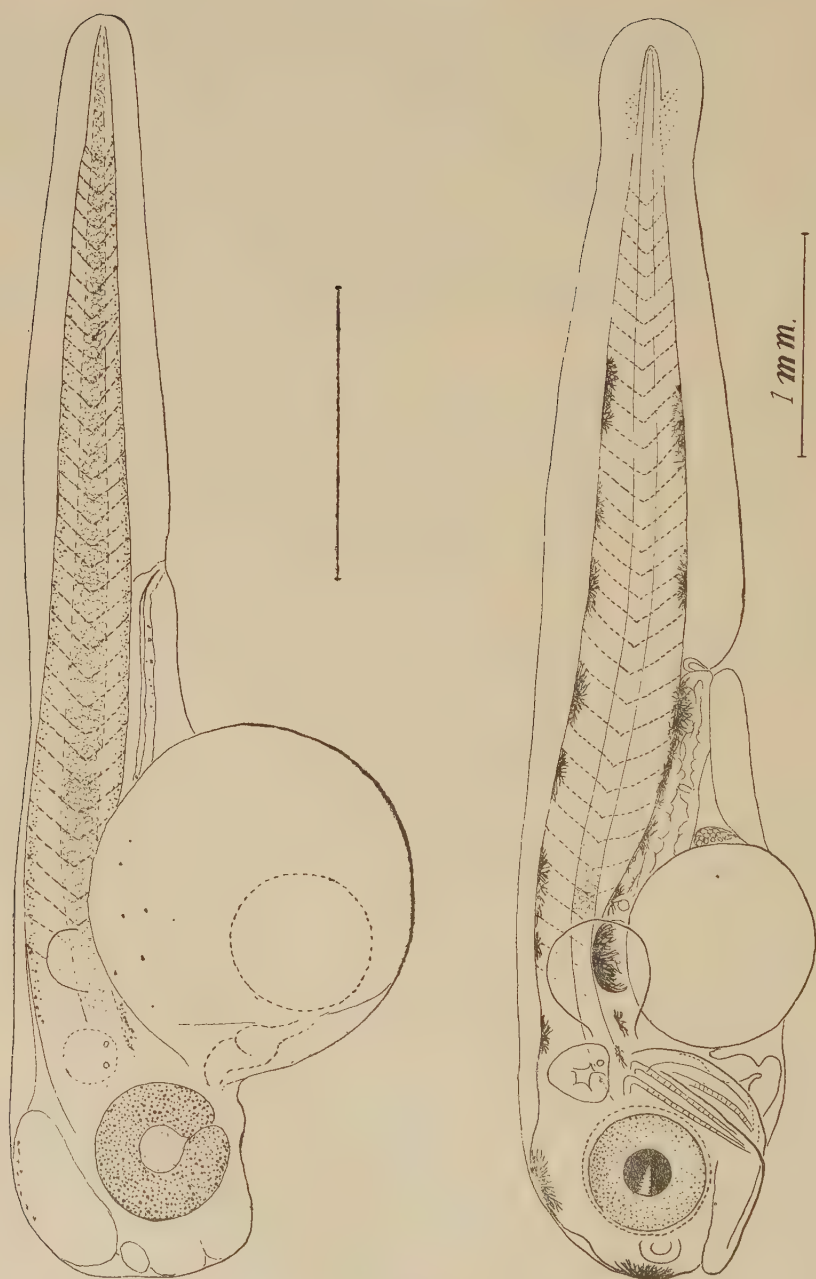
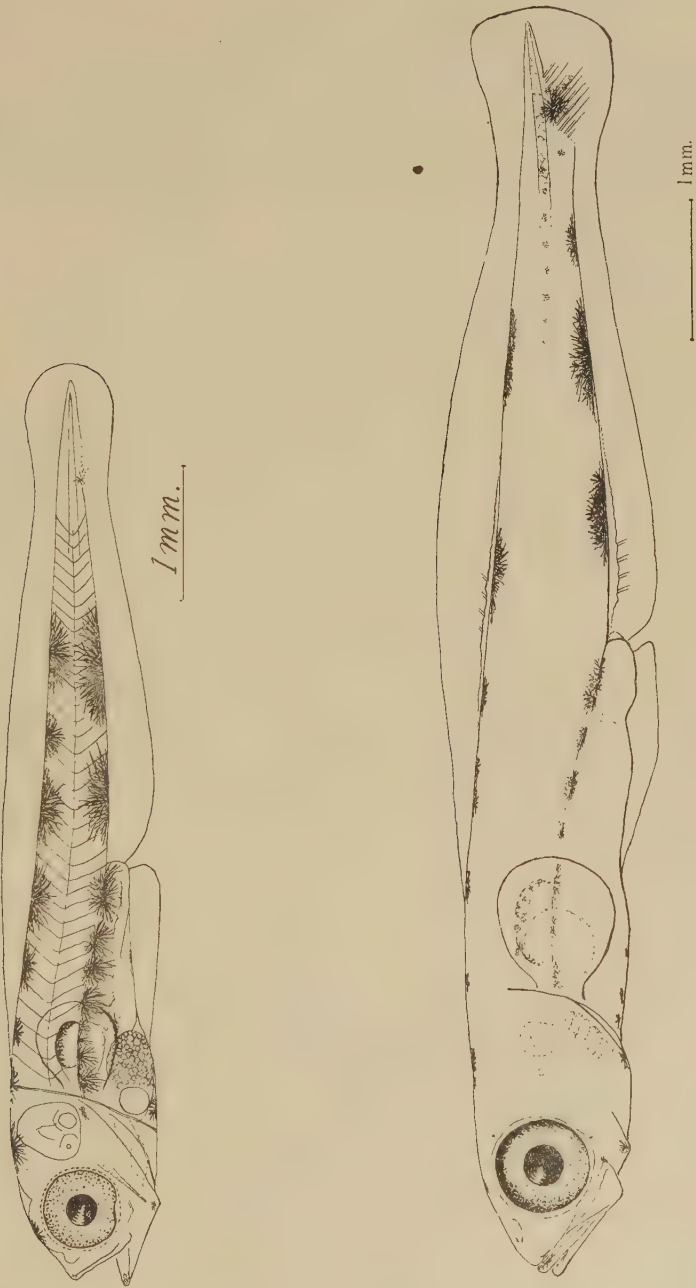


Fig. 11.



Figs. 12~13.



Figs. 14~15.

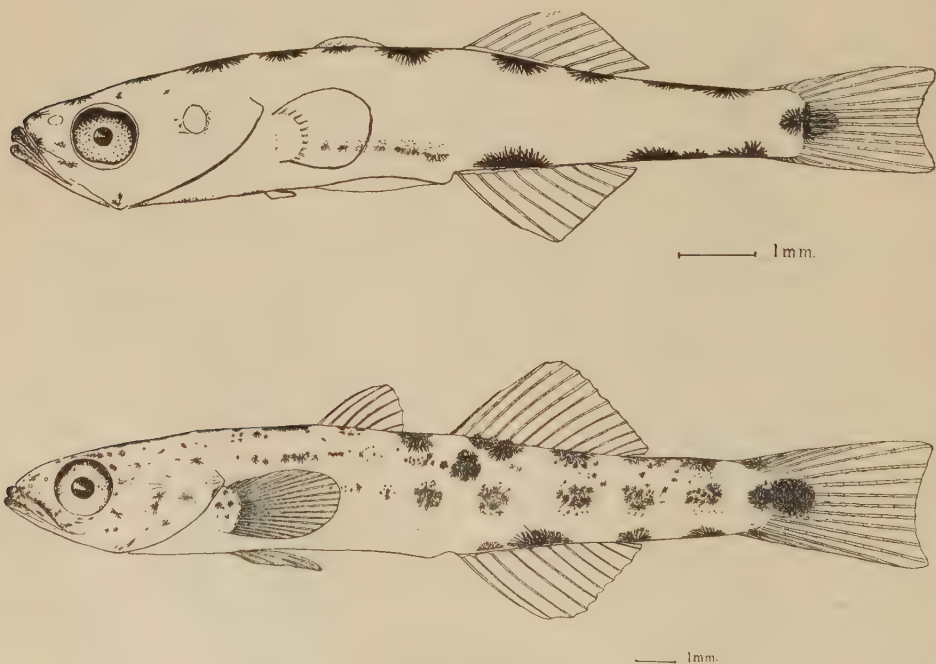
developed on the head and body, so that the body seems yellowish in colour.

In the post-larva of 9.0 mm. length (Fig. 15), the posterior otolith becomes very large. The rays of 2nd dorsal fin, anal fin and caudal fin begin to appear in the respective fins. The end of central skeleton is not yet bent upward, so the hypural bones are not complete. Lateral protuberant cells appear on the caudal fin. Yellow pigments of body become very distinct.

In a young fish 12 mm. long (Fig. 16), the larval fin still remains in the pre-anal region, but ventral sucker is formed; 1st dorsal fin begins to appear, but other fins are almost complete though the caudal margin is still concave.

The melanophore of caudal is large and spread over on the caudal fin.

The fishes of 13-15 mm. length have now lost their whole larval fins, and the ventral sucker becomes larger. In a 20 mm. long



Figs. 16~17.



Fig. 18

fish, the peculiar patterns begin to appear on the lateral side. They often rest or crawl on the aquarium bottom.

When the fish is 23.5 mm. long (Fig. 17), its caudal margin is still concave; lateral patterns become very similar to those of a certain stage of *C. dolichognathus* (Fig. 9), but distinguishable by the large black spot at the posterior end of the peduncle, and the yellow ground colour.

Crawling stage. In a 32 mm. long fish (Fig. 18), several upper rays of pectoral begin to separate from each other. The lateral patterns change to indistinct cross-bands which soon disintegrate into an irregular vermiculated pattern. A black curved wide band surrounds the caudal patch, with a narrow space left between them.

The change of the habit from the swimming to crawling occur in the young of about 25 mm. length. After above mentioned stage, the several upper rays of pectoral are completely separated, the caudal margin becomes rounded and the formation of all fins are now completed. Their colour and features become more and more similar to those of adult fish.

Comparisons. *Boleophthalmus pectinirostris* (Gmelin)⁹⁾ and *Periophthalmus cantonensis* (Osbeck)⁹⁾ inhabit sandy region and often burrow in sand. *Rhinogobius formosanus* Oshima,⁷⁾ *Gobius niger* Linne,^{6,8)} (*G. minutus* Pall³⁾ spawn their eggs on stone, wood, sea weed, and the inner surface of the dead shells.

Frederic Guitel observed that over the eggs of *G. flavescens* Fabr.⁴⁾ and *G. minutus* Pall³⁾ the males mount for guard, but I could not find two species of *Chasmichthys* guarding their eggs. These species of *Chasmichthys* are carnivorous at the swimming stage but when their habit changes to crawling their food habit also changes to omnivorous,

while *Bolephamus pectinirostris*⁹⁾ is carnivorous at the swimming stage and becomes herbivorous with the change to crawling habit.

The egg of two species of *Chasmichthys*, *B. pectinirostris*,⁹⁾ *R. formosanus*⁷⁾ and *G. niger*⁸⁾ is spindled-shaped, but that of *G. scorpioides* Collet,⁶⁾ *G. flavescens*,⁴⁾ and *P. cantoensis*⁹⁾ is elongated ovoid and of *G. minutus*³⁾ rather pyriform.

The egg of *C. dolichognathus* and *C. gulosus* is large, measuring 4.0 mm., while other eggs of gobioid fishes are small and as far as my research goes, there is no record that the length of egg is larger than 2.5 mm. Moreover, just hatched out fry of these two species are large and 6.0 mm. in length, certainly larger than those of other gobioid fishes.

In *B. pectinirostris*⁹⁾ and *P. cantoensis*⁹⁾, when their habit changes from swimming to crawling, the body is said to shorten. Thus I carefully cultured *C. dolichognathus* and *C. gulosus* in the aquarium and measured their length at the state of living from spring to summer of 1935.

The fishes become shortened occasionally for one or a few days. But I can not admit that the fact of shortenning of the body when their habit changes from swimming to crawling. But I must note that the pattern of body becomes irregular when *C. dolichognathus* attains to about 20 mm. length.

Of the pigmentation of post-larva, there are two types: one is that the black pigment never occurs except on the eye as seen in *Pterogobius elapoides* (Günther) and *B. pectinirostris*⁹⁾ etc., and the other is that black pigments are present along the ventral side of post anal region as in two species of *Chasmichthys*, *G. minutus*,²⁾ and *G. niger*^{1, 2)}, etc.

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V. *Pterogobius elapoides* Günther

The gobioid fish with 7th caudal band wanting and called *Pterogobius daimio* Jordan & Snyder, is found in the seas of Misaki, Wakanoura and Kominato. Another allied form of fish with 7th band perfectly formed is named *Pterogobius elapoides* Günther, and known from the seas of Aomori, Hakodate, Usitu, Nagasaki and Kumamoto. But *P. daimio* Jord. & Sny. was regarded as the same species as *P. elapoides* Günther by Dr. Tanaka. I completely agree with his view, the basis of which is given in the present paper.

The post-larvae of this fish are found in coastal region together with those of other gobioid fishes during winter and spring in the vicinity of Kominato. I made observations on the developmental stages of this fish, from post-larval to immature ones in 1933 and 1934 by rearing it. Special attention was paid to changes of body form and speckles in order to decide the question as to whether or not the peculiar speckles warrant us to recognise two different types among the specimens of this fish.

The author is indebted to Prof. A. Terao under whose supervision the present work was undertaken, and to Dr. S. Tanaka and Mr. K. Uchida who have given him kind advices and to Mr. M. Katayama who has favoured him several specimens caught in Inland Sea of Japan.

Habit. It appears that the spawning season of this fish extends from December to March near Kominato, since post-larvae which are smaller than 10 mm. are abundant at the sea bottom from January to March, and young fishes about 40 mm long are found in April to May. None has succeeded to observe spawn and the early embryological stages of this fish, nor could I have the chance of observing such objects.

Young as well as adult fishes live where *Sargassum* grows well, but the majority of post-larvae are collected from the sandy bottom where

the small stones are occasionally found and the weed seldom takes root on the stones. Young fishes which live in algal zone mostly aggregate in the interspaces where the bottom is exposed to sun light, sometimes suspending in the water almost motionlessly and sometimes making a dart to and fro just like those of many other gobioid fishes, but they suddenly hide themselves in algal thickets when one approaches them. Full grown fishes are not found suspending in the water but swimming near the bottom or creeping on it.

Young fishes always prey on the living little animals. I found Copepoda and *Cypridina* from the alimentary canal of several 25–50 mm. long fishes which were captured in February to April, 1935. Immature fishes larger than 60–70 mm. length have an omnivorous habit. I gave them the sea-weed, *Enteromorpha*, the eggs of fishes, octopus, crab, larvae of the crab and other planctonic organisms and also the larvae and pupae of a certain mosquito, *Aedes togoi* Theobald, all of which served as good food for them.

Formation of the speckles. I shall here dwell on this subject in detail, although Uchida already gave semi-diagrammatic figures³⁾, and I described a part of the young stages¹⁾.

The speckle-formation does not go hand in hand with body growth so that some small fishes are furnished with rather advanced speckles and some others of nearly the same size are not. Stages are recognized in the present paper mainly according to the advancing degrees of speckle-formation.

Stage I. Larval or post-larval stage. Larval fin still remains in certain parts of body.

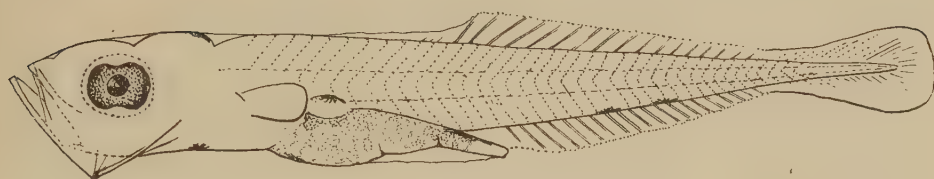
Stage II. Young stage. The body is not yet furnished with any speckle but that of the caudal base.

Stage III. Young stage. Cross bands begin to form on the body.

Stage IV. Young stage. Cross bands are completely formed.

Stage V. Immature stage. Speckles and body outline are as completely formed as in the adult.

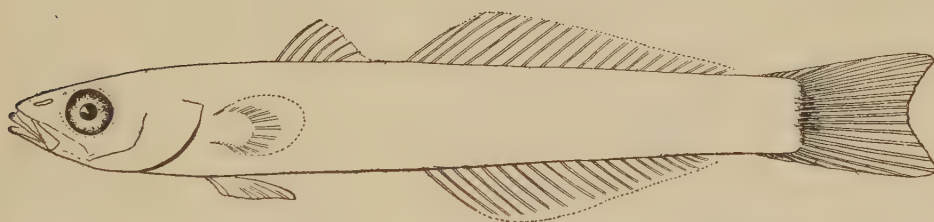
Stage I (Fig. 1, total length 6.2 mm.). The fishes at this stage do not attain a length of 7 or 8 mm. Fig. 1 shows that the larval fin still remains in preanal region, but the permanent rays of 2nd dorsal and anal are being laid down in their anterior portions. Lower jaw extends slightly beyond the upper, so that mouth is very oblique. The sucker is not yet formed at ventral. Black pigments are seen on



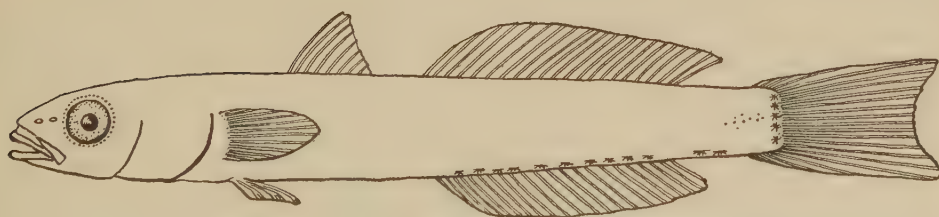
1 mm.



— 1 mm.



1/2 cm.



— 1 mm.

Figs. 1~4.

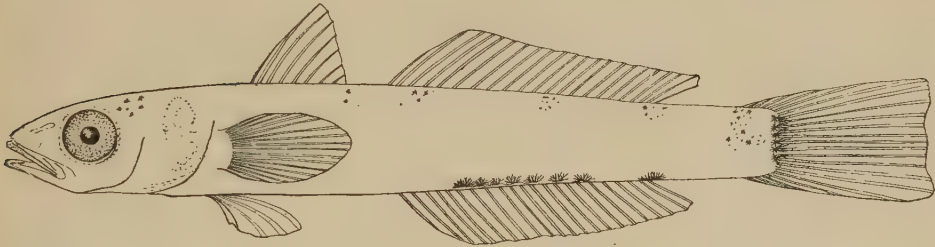
the breast, abdomen, lower margin of tail (post anal) and on the roof of the straight intestine as well.

Stage II (Fig. 2, total length 9.5 mm.; Fig. 3, total length 17.0 mm.; Fig. 4, total length 20.0 mm.). The fishes about 90 mm. to

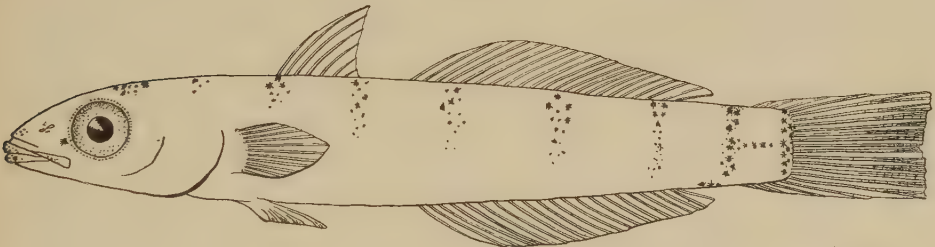
20.0 mm. in total length are referable to this stage. Larval fins have already disappeared. At an early period of this stage, the fishes are not provided with 1st dorsal fin, but with 2nd dorsal and anal fins, in each of which 20 soft rays are present. Abdominal sucker is formed; extremity of caudal is forked; mouth is still oblique; body is translucent and the black pigments are found on the abdomen, roof of intestine, and basal line of anal and caudal where the pigments are more or less arranged in rows running towards the membrane of caudal fin (Fig. 2). In a little older fish, the 1st dorsal fin is clearly formed, but in other respects the fish is nearly the same as before (Fig. 3). In a still later period of this stage, the rays of all fins amount to respective fixed numbers: 8 spines in 1st dorsal fin, and 22 soft rays in 2nd dorsal and anal fins. The caudal is still slightly forked; the mouth is more or less horizontal. The pigments are more widely distributed on caudal base and stretch in root-like manner on the caudal fin. Somewhat scattered black pigments run horizontally on the caudal peduncle close to the caudal fin (Fig. 4).

Stage III (Fig. 5, total length 21.0 mm.; Fig. 6, total length 22.0 mm.). This stage covers the total fish lengths ranging from 21.0 mm. to 25.0 mm. The fish is provided with well developed pectoral, although several superior soft rays of it are not yet separated. The caudal is very slightly concave or truncate at tip, and its soft rays are distinctly jointed. The body form is not so much different from that of the previous stage. The cross bands, characteristic of this fish, appear at this stage; 6th band is situated at caudal peduncle, 5th near the posterior basal end of 2nd dorsal fin, 4th near 13th soft ray of 2nd dorsal fin, 3rd a little behind the insertion of 2nd dorsal fin, 2nd at the posterior basal end of 1st dorsal fin, and the first at the insertion of 1st dorsal fin. The formation of these bands proceeds from backward to forward, as stated above. The horizontal group of pigments near the caudal fin becomes more obvious and connected with 6th cross-band. Scattered pigments make their appearance on the head, specially near the eye. The cross bands soon begin to elongate toward the ventral side. Meanwhile, some other speckles appear between occiput speckles and 1st cross band (Fig. 6).

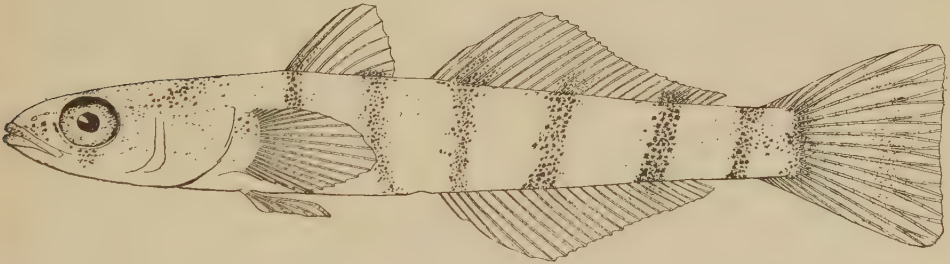
Stage IV (Fig. 7, total length 30.0 mm.). The fishes of this stage measure 22.5 mm. to 38.0 mm. in total length. The scale-formation begins to take place at this stage. The caudal is almost truncate at



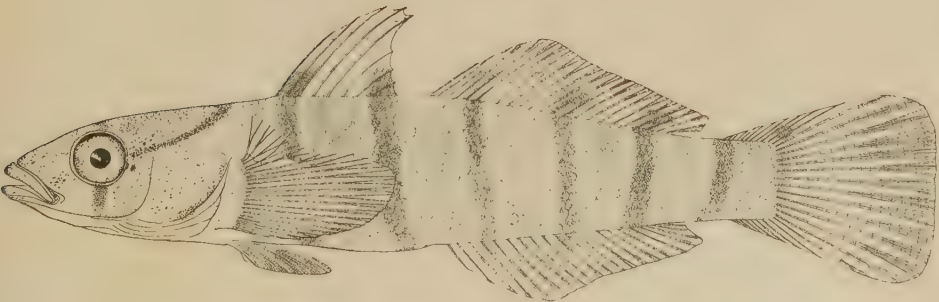
— 1 mm



— 1/2 cm.



— 1/2 cm.



— 1 cm

Figs. 5~8

tip. Several upper rays of pectoral begin to be separated. The body shows barely light reddish tint; 1st to 5th cross bands grow longer reaching beyond the base of the dorsal fins, and 4th and 5th cross bands beyond those of the anal fin. Three black bands appear around the eye: one under it, one above it, and another obliquely behind it. All these are directed toward the eye (Fig. 7).

Stage V (Fig. 8, total length 54.5 mm.). The fishes more than about 30 mm. length are referable to this stage, which is characterized by having the external features almost the same as those of the adult fish. The caudal is truncate or slightly convex at tip; 3rd and 4th spines of 1st dorsal are rather elongated but still a little shorter than those of the adult; entire series of scales are formed; upper jaw is almost equal or slightly longer than lower one, the pectoral is similar to that of the adult in outline with its 5 soft upper rays bifid at tip and separated from others. The 7th cross band which existed at base of caudal disappears, although in a fish below 45 mm. length, this band is faintly visible. When the fish is over 45 mm. in length, the cross bands are bordered by light yellowish tint, but the black speckle running from snout to eye disappears.

Remarks on the specific name. As stated above this fish forms,

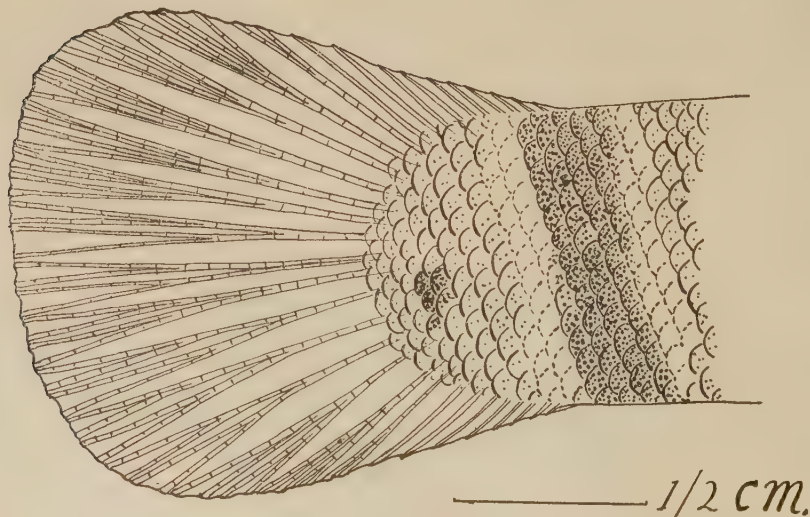


Fig. 9

first of all, 7th cross band at the posterior end of caudal peduncle; subsequently, 6th to 1st cross bands appear from backward to forward.

The disappearance of the speckle situated between snout and the eye and that of 7th cross band complete the "daimio" form of this fish. But 7th cross band seldom remains as a blotch or a spot, even when the total length of the fish is over 50 mm. Such spot usually exists at the base of the caudal fin as shown in fig. 8, but sometimes near the end of caudal peduncle (Fig. 9). The specimens from Inland Sea have the spot in question sometimes more distinctly than those of Kominato. It may be mentioned that some of Inland Sea specimens have the pigment spot on the right side of distal part of the caudal peduncle only.

On May 2, 1934 several hundreds of this fish measuring 40 to 50 mm. in total length were obtained near the Kominato laboratory, including a number of specimens, caudal base of which are speckled with the black spot. They were kept in the aquarium until June 7, 1934, when they attained over 70 mm. in total length. Most of them were found devoid of the spot on both sides completely or almost completely, but one of them was seen with the spot on the right side only.

Thus, it is clear that *Pterogobius daimio* Jordan and Snyder which designates the form without 7th cross band should be synonymised with *P. elapoïdes* Günther, type of which is characterized by having all the seven cross bands. It may be mentioned that Tanaka already synonymized the two although he did not mention the change of the cross-bands with the age.

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VI. *Alectis ciliaris* (Bloch).

Various ichthyologists have reported on the variations of the body form exhibited in the peculiar carangoid fish, *Alectis ciliaris* (Bloch), but none has elucidated the complete series of the changes of the body form with the age.

In this report is given a detailed account of the changes in various parts of the body of the species in question, together with a discussion on the specific name.

The specimens amounting to 143 in number and ranging from 32.0 mm to 72.0 mm in length were mostly obtained by the author from the fishing grounds of Kominato, Amatsu, Kamogawa, Wada, and Sirako in Tiba Prefecture. Three specimens of unknown locality and kept in the Zoological Laboratory of Imperial Fisheries Institute, one specimen obtained from Riukiu Islands by Mr. M. Katayama, and a number of specimens from Misaki, Bonin Islands, and Riukiu preserved in the Imperial Museum in Tokyô also came under my examination.

The author fully acknowledges his indebtedness to Prof. A. Terao for his kind supervision and to Dr. Y. Wakiya, and Ass. Prof. K. Ebina and others who helped me in various ways.

Changes of proportions of bodily parts with age. The changes of the body form as shown in Figs. 2~7 take place in various parts of the body. With a view to making clear the gradual changes of various bodily parts, the measurements were done as illustrated in Fig. 1. A part of my measurements is plotted against the body length in Fig. 8, but some comments should be made on each successive stage of transformation.

In passing, it may be argued that a larval or a post-larval stage is perhaps still characterized by elongated body form as is the case with other carangoid fishes. But the increase in depth continues until the fish attains a length of 20~30 mm when the depth is almost equal to the length of body. After that the depth becomes less than the length. In this connexion it should be borne in mind that individual variations under consideration may be partly due to the sex difference which was unfortunately not determined in both young and adult since they were caught in winter.

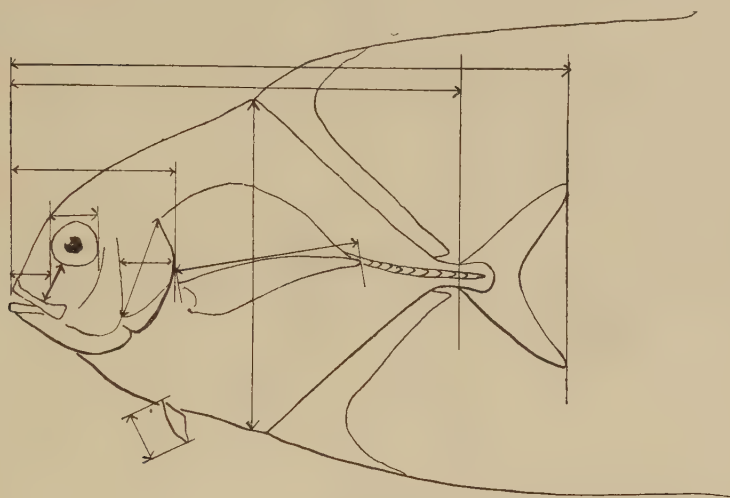


Fig. 1

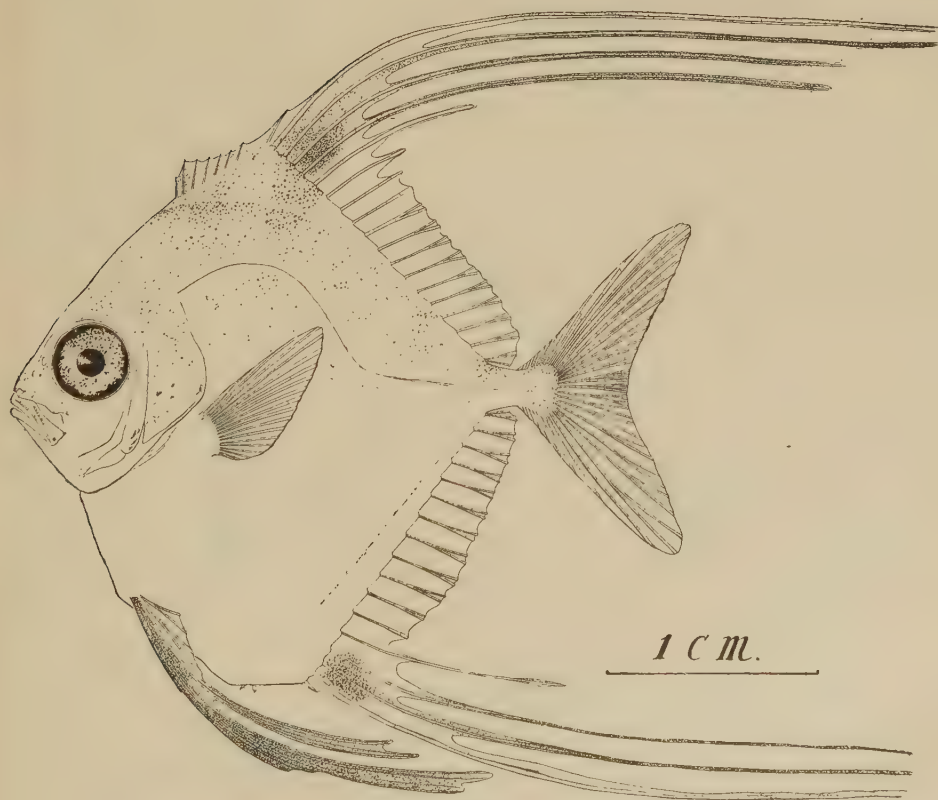


Fig. 2

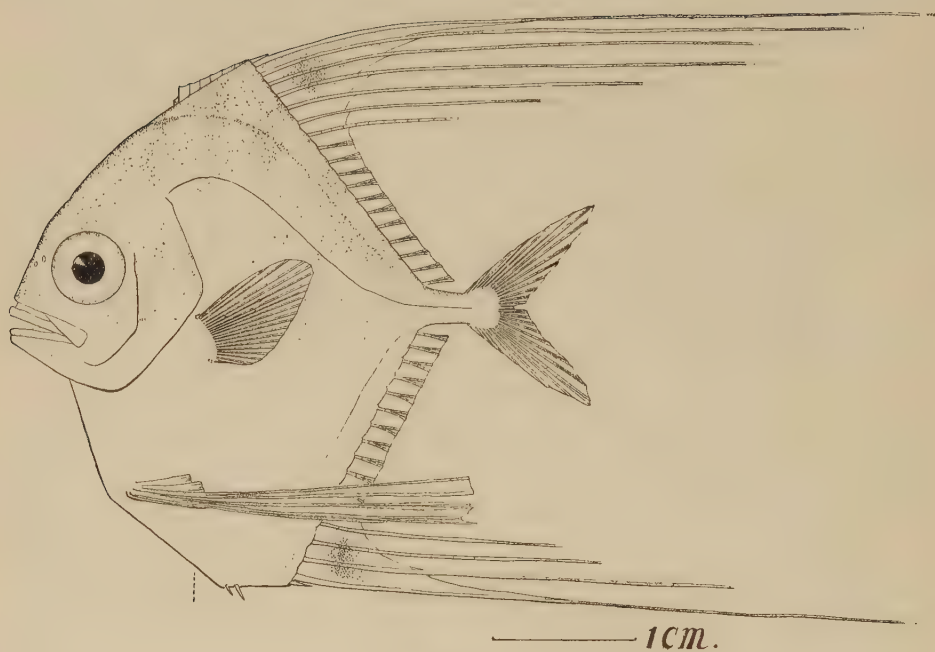


Fig. 3

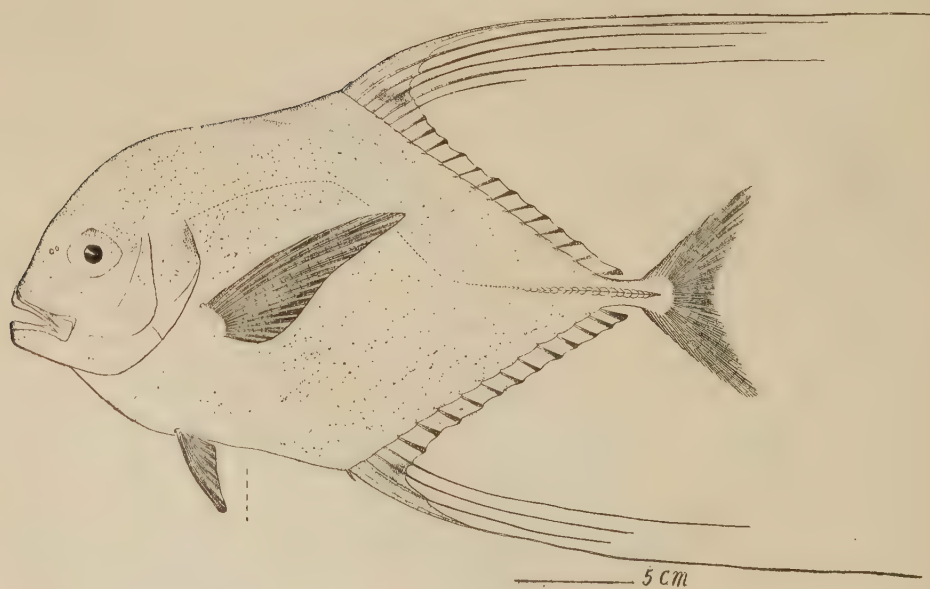


Fig. 4

In the smallest specimen which I obtained depth measures 0.85 in body length.

In a young fish less than 50 mm length, the depth is higher than length of body, but in medium-sized fish, varying from 50 to 80 mm., the depth is almost equal to length of body. The fish more than 80 mm in length has the depth lower than length of body.

Hand in hand with the change of proportions, gradual change of contour of the body takes place as shown in Figs. 2~5 and 7. When the fish is less than 70 mm in length the dorsal contour ascends from tip of snout to insertion of second dorsal fin with slightly convex curvature, and then it abruptly descends to the base of caudal peduncle with a straight line which makes an obtuse angle with the anterior ascending contour line. The ventral contour is remarkably polygonal. A steep line runs from the throat to the breast, at which the line changes the direction less steeply toward the first anal. The contour line runs almost horizontally along the anal, at the third spine of which the contour line abruptly ascends to the caudal peduncle.

In a fish measuring 70~100 mm in length the depth becomes less than the total length. Its dorsal contour ascends from the tip of snout to dorsal fin less steeply but with more convexity than that of the previous stage. But the dorsal contour just in front of the dorsal fin is nearly straight or a little concave. The line leading to the end of dorsal fin is straight as in the previous stage but it intersects with the caudal peduncle at a less angle. The ventral outbulging of the outline is much less marked than before, especially in the anterior half, i. e., from the throat to the insertion of the anal; the ascending contour line along the anal intersects with the caudal peduncle at an angle nearly equal to the dorsal corresponding one.

At the time the fish is nearly 100 mm long, the depth is still less than the total length. The curvature of the profile from snout to occiput is much more convex. The ventral contour forms first concavity at throat and then convexity at breast but these curvatures are not so much strong.

The largest specimen which is 635 mm long (Fig. 5) has the body elongate, occiput strongly curved, nearly straight ventral profile from the throat to anal insertion, and posterior halves of dorsal and ventral contours intersecting with the body axis at a much less angle. The proportions of various parts of body vary with age as shown in the

following lines.

Head 2.46 to 3.78 in body length; opercle width 1.82 to 3.00 in its length; snout 2.28 to 0.73 in eye, exceedingly variable; preorbital 3.40 to 1.00 in eye; interorbital 1.47 to 0.85 in eye; eye 2.19 to 3.64 in head; snout 4.44 to 3.80 in head.

Forms of soft dorsal and anal fins do not so much change with age. Spinous dorsal consists of 7 spines and membrane, but these spines are imbedded in the muscle in larger fish. But spinous dorsal of young fish is quite distinct, with its first spine short, the second one the longest, and the following spines in descending order in height.

Fin membrane is always well developed irrespective of age. Two spines of first anal, which are well developed but surrounded by poorly formed membrane in young fish, become embedded in muscle with growth. Anterior few rays of soft dorsal and anal are prolonged, but they are so fragile that they are easily broken when the fish is caught. Ventral 1.16 to 8.59 in body length. Value of ratio gradually increases from 1.16 to 1.5 or 1.6 when the fish attains about 60 mm. length but this value suddenly decreases from 1.5 to about 4.0 in fish about 90 mm long, after that it again increases with growth. Such a sudden change of the value in question is not merely due to decrease in relative

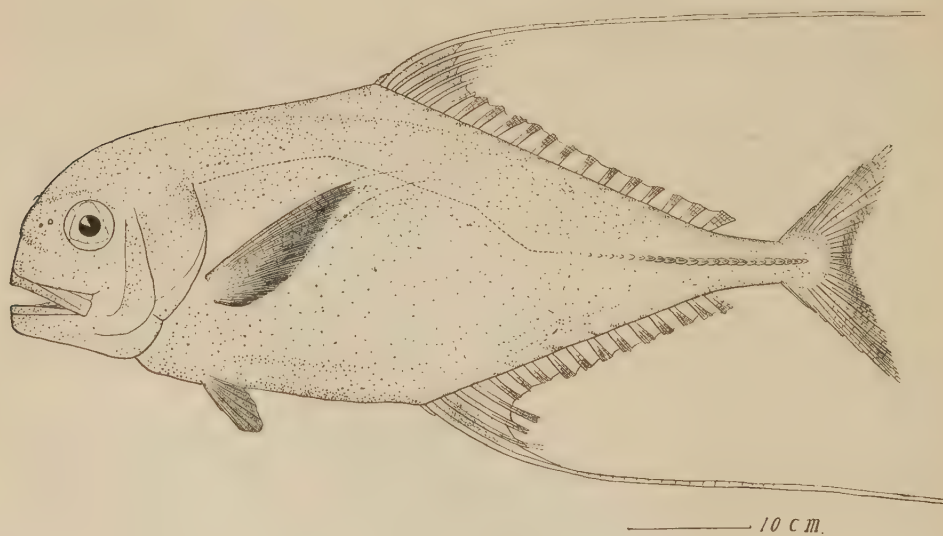


Fig. 5

growth of the ventral fin but also to the falling off of the distal part of this fin. The falling off takes place either in younger or older fishes, but mostly in medium-sized ones. The fin in question consists of 1 spine, 5 soft rays and membrane, anterior 3 rays being very long and posterior 2 rays short in young stage.

Pectoral 0.88 to 1.23 in head; it is shorter than head in fishes less than 50 mm long, but it is almost as long as head in the specimens 50 mm. to 120 mm. in length, and it becomes longer than head when the fish is still larger. It assumes a pointed sickle-form as the fish grows older. Fig. 6 shows its change in accordance with the growth of the fish.

Lower jaw is rather longer than upper, and the mouth is somewhat oblique. Such obliqueness is very remarkable in younger fish but is insignificant in older one. Scutes are large and strong on the caudal peduncle but their anterior members are weakly developed. Their development proceeds anterad from the posterior end so that it is always difficult to count the number of anterior members. In young specimens which are smaller than 30 mm. or 40 mm., it is wellnigh impossible to make out the scutes under the microscope, only the lateral line being visible at such stage.

Body of the medium-sized fish is lead-white in colour with metallic lustre on the dorsal side but merely lead-white on the ventral; six grayish black curved bands cross the body. These bands are not yet distinct in small specimens and they become fainter as the fish grows older, completely disappearing in the largest one which measures 635 mm in length. But a black blotch is seen on soft dorsal, covering several anterior rays, and another black blotch on anal anterior rays in every stage.

Discussion on the classification. Wakiya recognized five species of *Alectis* from Japanese waters.¹⁰⁾ But Max Weber and L. F. de Beaufort reduced these five to two species,¹¹⁾ *Alectis ciliaris* (Blotch) and *Alectis indica* (Rüppell). Since *Alectis major* of Wakiya is identical with *Alectis indicus* of Weber and de Beaufort, Wakiya's other 4 species should correspond to *Alectis ciliaris* of Weber and de Beaufort.

According to Wakiya, depth and body length are almost equal in *A. ciliaris* but body length is longer than depth in others. Since my measurements of the specimens show that depth-length relation gradually changes during the growth of fish, it is impossible to rely on this character for distinguishing the species. If this character be only

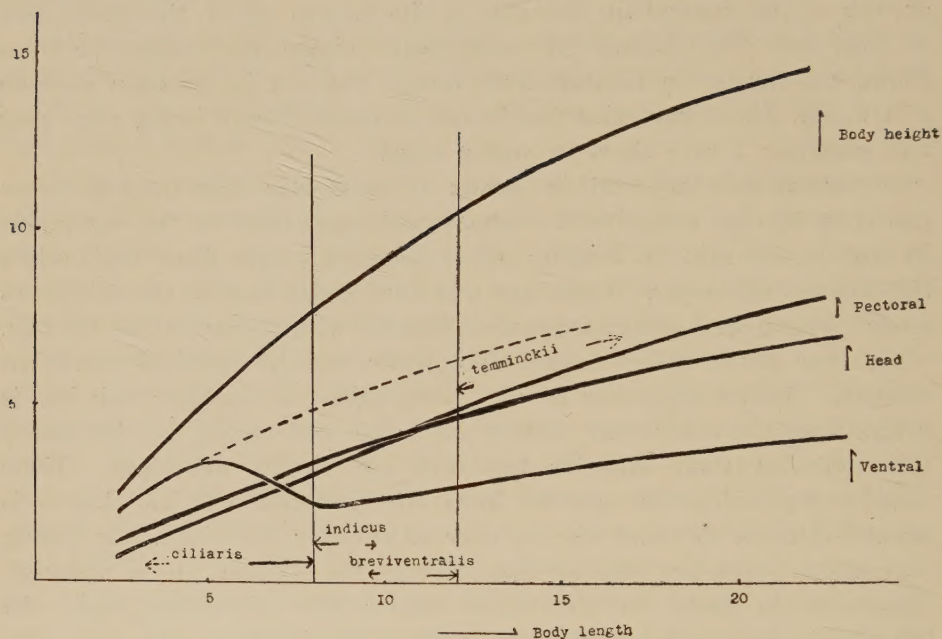


Fig. 6

criterion, only the specimens ranging from 50 to 80 mm are referable to *A. ciliaris*. Allowance be made to include the specimens with depth higher than length under this species, all smaller than 80 mm length should be furnished with that name. *Alectis ciliaris* was defined to have width of opercle rather broader than half of its length, but my observations as given above do not warrant us to adopt it as a criterion for distinguishing the species.

Alectis ciliaris and *A. indicus* were described to have snout shorter than diameter of eye, whereas *A. breviventralis* and *A. temminckii* were known to have both almost equal. It goes without saying that the first two should be applied to the specimens under 200 mm.

In *A. ciliaris* and *A. indicus* the preorbital is said to be one half of eye, and in *A. breviventralis* and *A. temminckii* the preorbital two-thirds of eye. In other words, the first two have larger eye than the second two, comprizing the specimens under 150 mm length.

In *A. ciliaris* and *A. indicus* the interorbital is given to be shorter than the eye, and in *A. breviventralis* and *A. temminckii* both are almost equal. This is another case where the character in question is confined

to young fish less than 150 mm. in length.

A. ciliaris, *A. indicus*, and *A. breviventralis* have the pectoral fin almost equal to head, and *A. temmincki* has the pectoral longer than head. My observations point to the conclusion that the fourth is more advanced one in growth than the others, corresponding to those with 120 to 140 mm length. The pectoral fin in some specimens of *Alectis breviventralis* is written to be longer than head. But as already remarked, there is considerable individual variation in the length of pectoral, so that it is not easy to distinguish the species by the relation between head length and pectoral length. Moreover, pectoral fin was put on record not to be pointed in *A. ciliaris*, but falcate and pointed in others. It would be superfluous to say that such is variable character with age (Fig. 6).

That upper contour of head of *A. ciliaris* is more gently curved than in others is nothing but a character bound with age as revealed by my study. Fluttering long ventral fins of *A. ciliaris* and *A. temmincki* are characteristic to specimens under 80 mm, which still retain such length of the fin up to this size.

From the reason given above, I can not recognize these 4 distinct from each other so that *A. indicus*, *A. breviventralis* and *A. temmincki* should be united with *A. ciliaris* as remarked by Max Weber¹¹⁾ and S. Tanaka⁹⁾.

Finally it may be mentioned that the greatest one of my specimens is very closely allied to *Hynn timeria hopkinsi* Jordan & Starks which was recorded from Mazatlan, and also to *Caranzoides ajax* Snyder (= *Hynn timeria ajax* (Snyder)) which was obtained from Honolulu.

Anterior soft rays of dorsal and anal are not prolonged in *Hynn timeria*, but it is very probable that prolonged rays are normally present in *Hynn timeria* but often become shorter by breaking. Still it could be thought that *Alectis* and *Hynn timeria* are distinct. Oddly enough, all specimens of *Hynn timeria*, *H. goreensis*¹⁾ (type species), *H. cubensis*,^{6, 8)} *H. ajax*,⁵⁾ *H. hopkinsi*⁴⁾ and *H. mosma*,³⁾ are 2 to 3 feet in length. Inasmuch as there are no specimen under 2 feet reported in any species of *Hynn timeria*, it is very likely that *Hynn timeria* is a full grown type of *Alectis*. It is worth noticing that the body height of *Hynn timeria* is much lower than that of *Alectis*, considering that the depth becomes lower when *Alectis* grows older.

Hynn timeria hopkinsi and *Hynn timeria ajax* bear close resemblance to each other and to my specimen No. 6; and *Hynn timeria hopkinsi* shows an inter-

mediate type between No. 59 and No. 6 of my specimens.

Thus, *Hynnys hopkinsi* and *H. ajax* appear to be identical with *Alectis ciliaris*. *Hynnys goreensis* and *H. mosma* are perhaps synonymous with *A. indicus* (Rüppell), because of characteristic profile of head. But the question is still an open one. I could not examine the figure of *H. cubensis*⁸⁾ Poey, so that I am not in a position to discuss the validity of the species. The conclusion I reached is graphically represented in Fig. 7.

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